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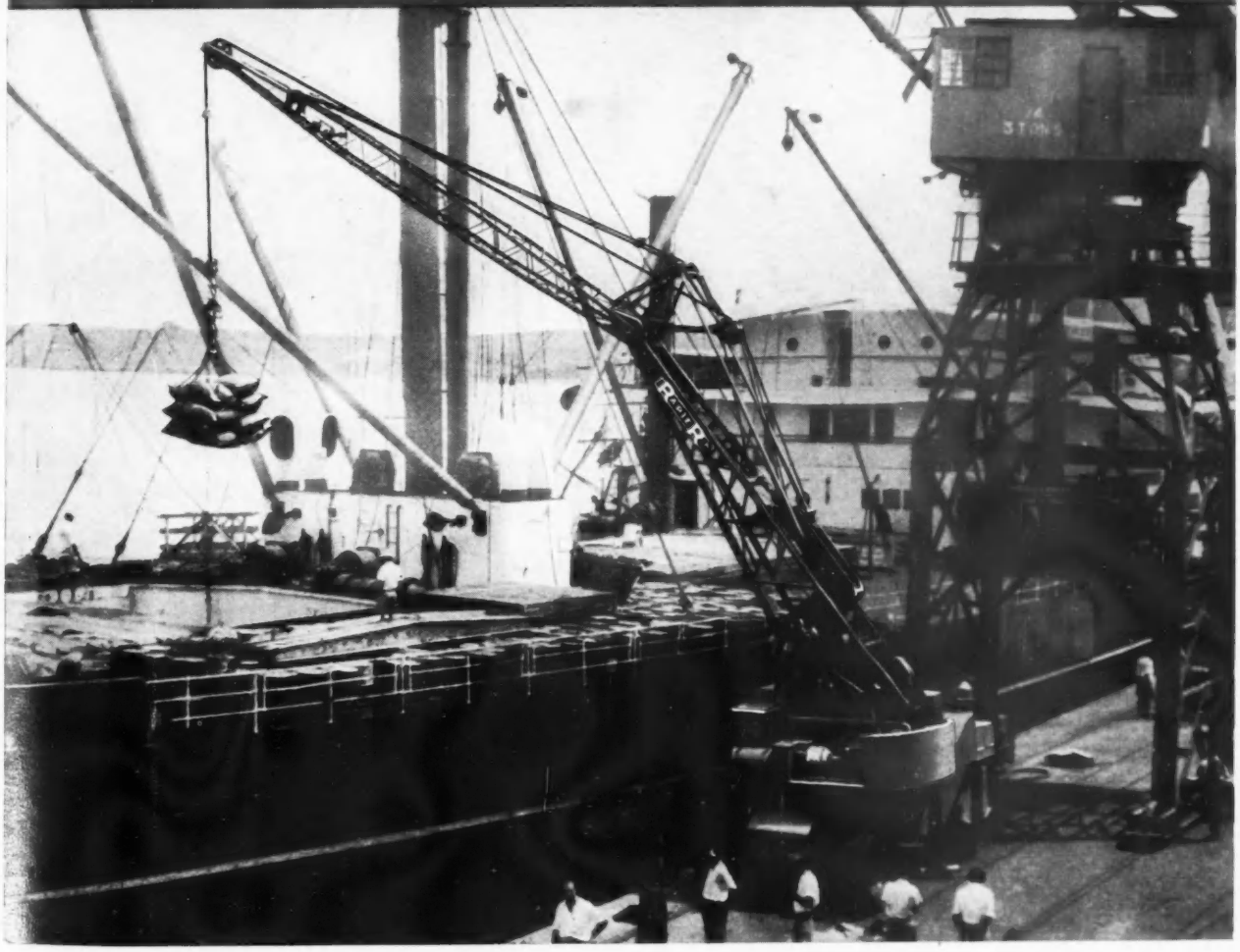

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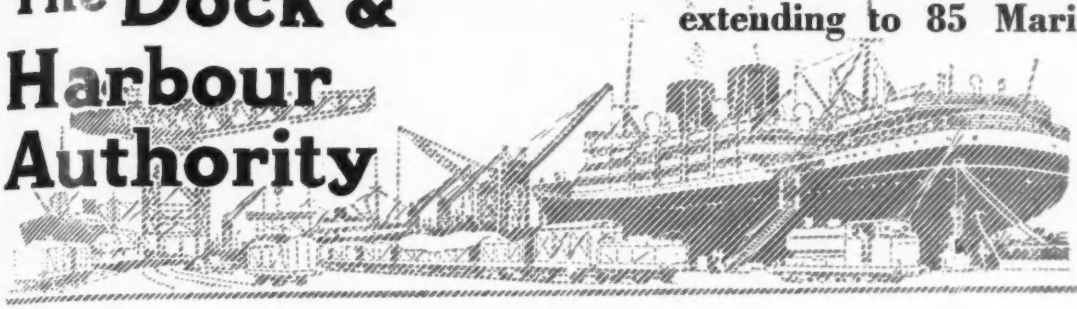

No. 450

Vol. XXXVIII

APRIL, 1958

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Editorial Comments

Improvements at Devonport, Tasmania

The leading article in this issue deals with improvements which have recently been carried out for the Marine Board of Devonport, Tasmania. The author describes the construction of wharf extensions using reinforced concrete pontoon caissons, the design of which involved a number of novel and interesting features. The improvising of equipment built on the site of the work in the absence of heavy plant, which was unobtainable during the years immediately following the Second World War, is also of interest.

The old berthage, built in 1913-1916, comprised a marginal wharf 1,000-ft. long. It was a timber structure with a rear retaining wall of pre-cast concrete L-shaped units set between low water and deck level on a rubble bank, the combined walls holding a clay and sand fill to provide access roads, yards and cargo sheds.

These facilities were found inadequate for a growing trade and the new works were required to provide an additional 650-ft. of marginal berth, together with cargo sheds and space for road and rail traffic at the rear. Though the type of construction which was finally adopted has been used previously in Europe and Japan, it appears to be the first time it has been employed at any port in Australasia.

Shipping and Trade at the Port of Liverpool

Two notable centenaries are being celebrated this year—those of the Liverpool Steam Ship Owners' Association and of the Mersey Docks and Harbour Board. These two organisations have been linked throughout their existence and indeed, ten of the shipowner representatives on the Board are nominated at the instance of the Association. Reference is made in the annual report of the Association—which covers as usual a wide range of subjects—to the fact that since 1858 the two bodies have worked closely together for the well-being of the port. In the hundred years that have now elapsed, the tonnage entered in the Association has grown from 70,000 to just over 4,600,000 gross tons and the membership from six to 26.

As the report observes, the extension of the trade of Liverpool has been the work of many men, but the basis of it has been its ships. The part played by members of the Association is indicated by the fact that, for as far back as details are available, the greater part of the port's revenue from rates on ships and goods has been derived from vessels owned by the holders of appropriated berths and from the cargoes carried by these ships. The regular lines holding such berths have almost all been members of the Association. And, apart from thus carrying the greater part of the trade of the port of Liverpool, the members of the Association have had, and have to-day, vessels regularly engaged in almost every port of the world and in all other major ports of the United Kingdom.

In 1857, the year before the Association was formed, the tonnage of the vessels entered and cleared in the foreign trade of Liverpool amounted to 4,935,880 tons; in 1956 it exceeded 30,000,000 tons. The value of the exports from and imports into Liverpool in 1857 is estimated to have been about £100,000,000; in 1956 the figure was £1,620,000,000. The total weight of the whole foreign trade of the port — import and export — was 3,250,000 tons at the beginning and 13,637,793 tons at the end of the period, a truly remarkable record of progress.

A Search for Optimum Container Size

The Maritime Cargo Transportation Conference (M.C.T.C.) of the National Academy of Sciences, National Research Council, Washington, U.S.A., has issued several reports on matters of interest to the shipping industry. Some of these have dealt with various aspects of the modern tendency to transport goods in load form rather than as loose packages and the most recent publication (No. 558) is given the unwieldy title of "A Bibliography of Containerisation in Maritime Transportation of General Cargo."

At the 1958 Symposium of the M.C.T.C., a British Army Officer, Major H. A. Ablett, M.B.E., presented a technical paper entitled "A search for optimum container size." Extracts of this paper are printed on a following page in this issue. Although the author emphasises that he has only undertaken an illustrative example, he also expresses the hope that his method of analysis may prove to be of some assistance in solving many of the problems which will have to be overcome before an international solution is found for this method of transport.

The Growing Importance of Harbour Radar

Within the last few weeks it has been announced that the Port of London Authority is to inaugurate a navigation service to assist shipping and port operations. A similar announcement has also been issued by the Hamburg Harbour Commission, to the effect that Hamburg harbour and the adjacent stretch of the River Elbe is to be equipped with land-based radar stations. These developments indicate the growing appreciation of the importance of harbour radar to assist shipping in congested port approaches, especially during periods of reduced visibility.

Experience of harbour radar at a number of ports throughout the world has shown both shipowners and port authorities that these systems, in conjunction with the recently standardised marine VHF communication networks, offer great advantages and economies both of time and money. By increasing safety and helping to maintain a regular flow of incoming and out-going traffic, they enable full and expeditious use to be made of a port's facilities in clear weather as well as in fog.

Details of both the Port of London Authority's scheme and of the Hamburg installation will be found on a following page.

Opening of Sinclair Wharf at the Port of Belfast

A new deepwater wharf on the east side of the Herdman Channel, Belfast, is to be officially opened on May 9 by H.M. Queen Elizabeth, the Queen Mother.

The wharf, which is to be named Sinclair Wharf after the present chairman of the commissioners, Sir Kenneth Sinclair, has been designed to accommodate the growing foreign traffic of the Port. The quay, 1,250-ft. in length, is supported by reinforced concrete and steel box piles and the filling behind the quay is retained by a steel sheet pile facework, connected by means of tie-rods to concrete anchorages. It has been constructed on solid ground and the berthing area is being dredged to provide a depth of 30-ft. at ordinary low water. Provision is also being made for eventual deepening to 35-ft. should this be required.

A transit shed has also been provided capable of accommodating 15,000 tons of bagged goods or 10,000 tons of general cargo.

Editorial Comments—continued

There is storage space covering an area of 7,500 sq. yds. at the rear. The shed is carried on pile foundations and constructed with "N" type roof trusses giving a clear span of 120-ft. and a height clearance of 30-ft. over its full width. This type of roof construction keeps the floor area clear of obstructions and facilitates the operation of mechanical handling equipment. Most of the openings into the building are 18-ft. 9-in. wide and 20-ft. high, but every fifth opening is 28-ft. in height so as to permit mobile cranes to enter the shed with maximum loads.

Tests for Cargo Gear

The United States Coast Guard have recently announced their official recognition of the International Cargo Gear Bureau, Inc., New York.

This Bureau was formed to provide facilities on a non-profit basis for testing, surveying and certifying cargo gear on board ships as laid down by the International Labour Office Convention No. 32 on Protection against Accidents (Dockers). It has inspectors at 19 ports in the United States.

The main purposes of the Bureau are to facilitate the compliance with international cargo gear safety requirements and standards; to maintain a current library containing the international standards in effect throughout the world for the protection against accidents of workers employed in the loading and unloading of ships; to provide experienced competent inspectors to certify that the cargo gear carried on board ocean-going vessels complies with the international established standard; and to endeavour to eliminate misunderstanding regarding the various regulations for the certification of cargo gear by providing information on the international standards in effect and to aid in the implementation of these standards in the interests of safety.

Art. 9 of the I.L.O. Convention No. 32 calls for the thorough examination every four years and inspection every 12 months of ships' derricks and the thorough examination every 12 months of cranes, winches, blocks shackles, etc. It is required that chains and wire ropes should be adequately examined and tested, and the safe working load of gear certified by competent persons acceptable by the national authorities.

Nineteen countries have so far ratified the I.L.O. Convention, which was revised at the 16th session at Geneva in 1932. The signatory countries include the United Kingdom, Belgium, Canada, France, India, Italy, Norway, Pakistan and Sweden. The United States Government have not signed as yet.

Abstracts of Annual Reports

The Port of Melbourne

For the fourth year in succession, entrances into the port of Melbourne in 1957 exceeded 15 million tons gross. In all, 2,491 ships, aggregating 15,391,025 tons, entered the port. This is only 266,246 tons less than in 1956 and 1,041,768 tons less than in the peak year of 1955. These figures indicate the continuing widespread prosperity of the State of Victoria in spite of artificial controls to limit imports. Most of Victoria's seaborne trade, including 97 per cent. of the general cargo trade, passes through the port of Melbourne.

The vessels of 20 different nations berthed in the port during the year. British ships accounted for nearly 60 per cent. of the 1,292 overseas vessel entries. One of the outstanding features was the increasing number of Japanese ships. Japan now joins Norway and Holland as one of the three non-British countries whose ships visit the port frequently. In contrast with the previous year, overseas passenger embarkations and disembarkations in1957 showed a slight decline, while interstate passengers through the port showed a small increase. Embarkations at Melbourne comprised: Overseas, 20,510; interstate, 31,353; total 51,863. Disembarkations were: Overseas, 55,787; interstate, 28,825; total, 84,612.

Due to efficient administration and planning, virtually all vessels calling at the port were able to move immediately to port berths most suited to the needs of the cargoes they carried.

Queensland Department of Harbours and Marine

In the report of the Queensland Department of Harbours and Marine for the year ended June 30, 1957, it is stated that due to the absence of heavy rains on the watershed of Brisbane River, the dredgers were able to bring river channels and wharf berths to the required depths. During the year the gross quantity of material dredged from the port of Brisbane was 4,247,660 barge yards, compared with 2,899,110 barge yards in the previous year. The port of Brisbane is a dirty river estuary and in order that it may function efficiently must be dredged continuously. Recently acquired dredging plant is able to accomplish the work faster and at a lower cost than previously. With the advent of deeply laden ships it is more necessary than ever to keep cuttings to the full width of 400-ft., and with this aim in view, dredged channels will be widened to 450-ft. and deepened to 31-ft. L.W.S.T.

The Broken Hill Proprietary Company Ltd., wharf in Hamilton Reach is being extended to have a frontage of 830-ft., but with this exception there was no wharf construction during the year, although the France-Australia Line asked that its wharf be extended to have a total frontage of 1,200-ft. The report states that at the present time wharfage accommodation at Brisbane is sufficient to deal with the shipping that frequents the port.

The wheat bulk handling installation now being constructed at Pinkenba is making good progress, and work has begun on the shipping gallery which will be built on the upstream section of the Pinkenba wharf. At Mackay during the year the work to complete Queensland's first bulk sugar handling installation progressed favourably and the installation was declared open on July 27, 1957. In addition a new tourist jetty and waiting shed was built. Tenders were received for the construction of a deep-water port at New Bundaberg; the tender price accepted was £A645,322. The construction of the bulk sugar storage shed is proceeding. It is expected that the port will begin functioning for large coastal vessels during the latter half of this year. Preparations are being made at Townsville for the construction of a new finger pier together with sugar bulk handling equipment. It is expected that sugar bulk handling equipment will come into operation at Lucinda Point this year.

The report mentions work in progress on training walls which have been provided at Brisbane River to control tidal flow and protect harbour walls. At Coxen Point, Parker Island, and Bulwer Island training walls are also being built, and at Gibson Island some work is being carried out in preparation for this area to be used for wharves and industrial expansion in the future.

South African Harbours Report

According to a report recently published in the "South African Railway News," the steady increase in harbour traffic was maintained during 1957. During the year, 13,594 vessels called at Union harbours, compared with 11,500 in 1956. Cargo handled at all ports totalled 18,630,073 tons compared with 16,659,806 tons in the previous year, an increase of 1,970,267 tons. In the coast trades, there were 1,330 arrivals during 1957 as against 1,400 in the previous year. Cape Town recorded the greatest number of arrivals during the year with 6,351 (5,100 in 1956), followed by Durban with 4,147 (3,420 in 1956). While Cape Town was the principal passenger port, accounting for 64,235 out of a total of 159,967 passengers passing through the Union ports during 1957, compared with 59,790 passing through Durban, the latter headed the list in respect of cargo handled.

During the year 8,333,548 tons of cargo was handled at Durban (7,603,336 tons in 1956), compared with 5,686,543 tons (4,890,372 tons) at Cape Town. Of these totals 4,497,233 tons was landed at Durban (4,497,233 tons in 1956), 3,728,932 tons (3,398,018 tons) shipped, and 108,303 tons (94,891 tons) transhipped. The corresponding figures for Cape Town were 3,249,356 tons (2,811,532 tons), 2,391,038 tons (2,041,291 tons) and 46,149 tons (37,549 tons). Coal shipments, on the other hand, showed a decline against the figures for 1956. During 1957 401,834 tons was handled, compared with 482,105 tons in the preceding year. Ships' bunkers accounted for 163,055 tons (162,062 tons in 1956), and 238,799 tons was exported (320,043 tons).

Wharf Extensions at Devonport, Tasmania

Description of Revised Scheme of Development

By D. S. KENNEDY, A.M.I.C.E., A.M.N.Z.I.E., A.M.I.E. (Aust.), A.C.S.E.*

Introduction

THE writer was invited in 1948 to examine and report on the future development of the Port of Devonport, Tasmania, with a view to recasting a scheme of construction already started, but which was meeting with many difficulties owing to the general lack of adequate site and operational planning. The need for redesigning the wharf structure and reviewing the reclamation proposals was immediately evident so as to allow the building of the future berthage contiguous with the existing wharf and so overcome the disability of an already limited area, served by road and rail traffic, being divided into two parts, as then planned. Further, future development should be so planned that additions could proceed section by section within the economic resources of the Board.

Technical records were found to be very meagre and the almost complete absence of reliable information on prevailing winds, storms and the magnitude of floods, tidal currents, etc., presented a problem that all too often arises when small but rapidly growing ports require professional engineering advice. Again, as so often found in such localities, the riverside wharf is generally sited so close to the shoreline and a main street or busy thoroughfare as to make the provision of rear storage areas, rail and loading facilities, almost impossible, without completely demolishing or rebuilding the works on a fresh location.

Such ports began life by catering for a small coastal type of vessel but, with the rapid growth of a wealthy and fertile hinterland, larger and deeper draft shipping became necessary with a consequent demand for improved channels and wharf facilities. The vicious circle is so well known that it requires no further elaboration.

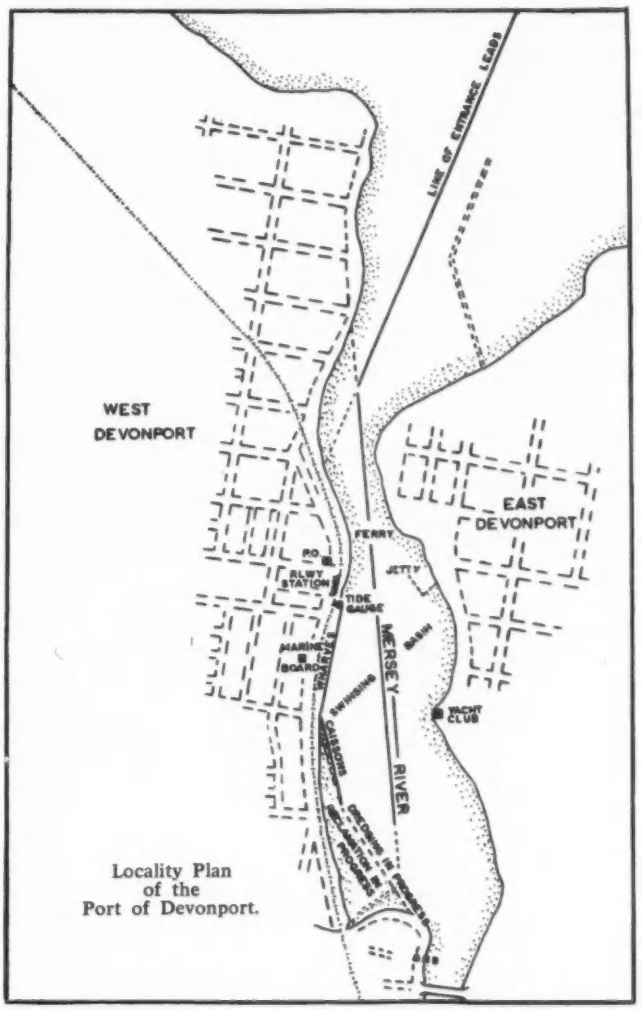
At the time of examining the proposals, labour and materials, and especially skilled tradesmen, were most difficult to obtain and greatly added to the problem. In 1949, the writer was appointed to the position of Engineer, to carry out the revised scheme of development, which by this time had received the approval of the Tasmanian Government and the Devonport Marine Board.

General Considerations

Devonport, a town with a population of about 12,000, is situated on the north-west coast of Tasmania, approximately 60 miles west of Launceston and 40 miles east of Burnie, all three serving rapidly growing districts. The two rival ports were already well served by excellent port facilities. Devonport, however, was fortunate in having the State Railways adjacent to the main wharf on the western bank of the river Mersey and sufficient room for immediate expansion of its berthage, cargo shed areas and transport requirements by reclamation of its upper harbour. This well-sheltered location is situated approximately one mile from the breakwater entrance where the Mersey River debouches into Bass Strait. This area, upstream from the existing wharf, was formed in early geological times, large sand banks being deposited, and these ultimately providing over one and a half million cubic yards of excellent filling for the new construction. A paper by the writer on this work has been published in the "Commonwealth Engineer," May 1, 1954.

Site Information

A programme of borings and soundings was undertaken to determine the nature of the harbour bed and these revealed areas of sand overlying heavy boulder clays. Where the old and new work was planned to junction, a thin layer of conglomerate and clay overlying a massive sheet of dolerite rock was found to extend generally in the direction of the new wharf alignment for some 400 to 500-ft. This was at a depth of round −28-ft. to −32-ft. below L.W.O.S.T. At the centre of the river the rock dipped sharply only to outcrop again at about the eastern low-water mark. The distance across the channel in this vicinity was approximately 800-ft. leaving little enough margin for a swinging basin unless widened by expensive rock removal.



Locality Plan of the Port of Devonport.

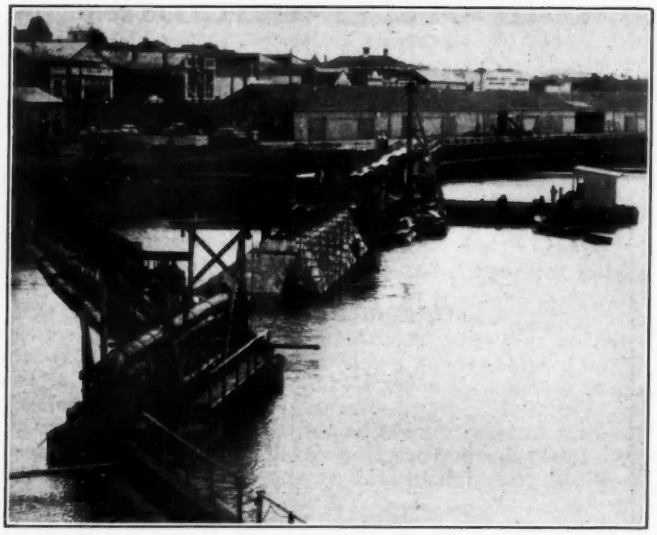
Layout

No increase in the basin dimensions could be gained by moving the new wharf alignment further westward as the whole of the existing shore layout was already overcrowded and bounded by rising ground. It was also vitally necessary to provide for further road and rail connections through the "bottle neck" to link up the old and new areas. A compromise was arrived at, providing a reasonable amount of swinging room in the basin, and, on land, a workable width of roadway and yard clear of rail tracks. With agreement among the interested parties, an overall plan was finally developed to meet these special difficulties.

The design stage was now reached and involved the provision

*The Author is now Harbour Engineer, Whangarei, N.Z., and this Paper is reproduced by permission of the New Zealand Institution of Engineers.

Wharf Extensions at Devonport, Tasmania—continued



Commencement of wharf with two caissons in position—superstructure being erected 1954.

of an immediate 650-ft. of new marginal berthage out of a possible 2,200-ft. At the rear of the wharf, an area of about 28 acres was to be reclaimed by dredgings removed from the main swinging basins. Space for cargo sheds, road and rail facilities and about 8 acres of land for leasing to industry were provided. The basin above the "hour-glass" rock formation gave ample room and with easy dredging, for a swinging circle of 1,000-ft. diameter and a future 1,200-ft. diameter if required. The Tasmanian Railways took a further 5 acres of reclamation to develop a goods and marshalling yard. As the interior wharf roads required new outlets to the Launceston highway, two overhead road bridges, crossing the main rail tracks, were included in the master plan. Road transport was found to be handling 60% of the cargo. Again it was most important that the works be designed to enable some degree of elasticity in the future use of the rear areas, and permanent roading was not envisaged in the initial phase.

Design Considerations

Entrance conditions generally control the size of vessels working Devonport. The minimum depth in the main channel and swinging basin is −24-ft. below L.W.O.S.T. Storms produce a swell of 3 to 6-ft. at the breakwater but these are very infrequent and seldom cause delays. Tides rise 10-ft. at springs and 8-ft. at neaps. Bottom channel width varies from 250-ft. at the narrowest part to over 300-ft. in the main reaches.

The maximum length of vessel, beam, draft and tonnage using the port up to 1948 was 550-ft., 72-ft., 24-ft. 6-in. and 12,680 tons respectively.

The annual trade at that time was approximately 230,000 tons and revenue round £50,000. Several oil companies were interested in establishing ocean terminals, and one company had already erected a depot. Rapid expansion of this trade could also be assured, with more wharf space and an additional berth to cater for the general cargo offering.

It was thus evident that new construction should provide for a length of vessel from 550 to 560-ft. and a draft up to 25-ft., it being considered that economic requirements would preclude, for some years to come, any greater dimensions than these. A swinging circle of 1,000-ft. diameter was allowed for, with a minimum of 850-ft. in the rock area. It was laid down as a general principle that no works bounding the swinging basin should constrict the free flow and ebb of the tide, that might cause eddies or conflicting currents in or through the main channels.

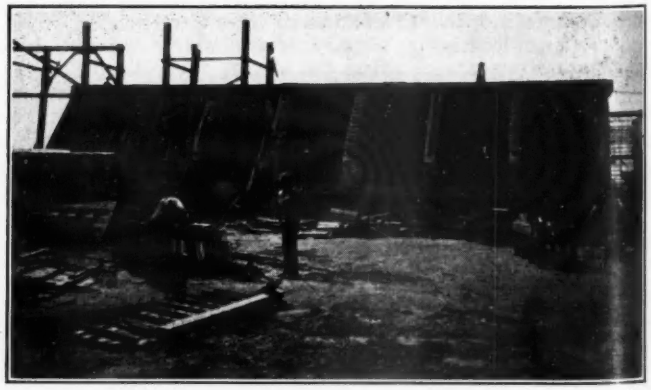
The two initial proposals were for a conventional reinforced concrete pile, beam and slab wharf with a rear sheet pile wall, and for a relieving platform type. In each case the wharf structure was designed to retain the dredged fill and provide the apron for rails and shed floors, etc. However, later borings having revealed the presence of a hard dolerite rock at −28-ft. to −32-ft. below low water, under the proposed wharf location, an entirely new design became necessary. A reinforced concrete deck on heavy cylinders with a steel pile retaining wall was designed but the great expense of diamond drilling and poor deliveries of steel piling finally ruled out this clean and very effective method of construction on rock.

As the new filling was nearly 50-ft. deep in this area, a substantial structure was required. Reclamation was already in progress and the idea of building reinforced concrete pontoon caissons was investigated. A search of technical literature on caissons revealed a novel and cheap method used in Poland many years ago at Gdynia where they were constructed on a sand bank and launched by undermining by dredging. These great concrete boxes formed a wharf platform and retaining wall in one operation and overcame the difficulty of founding in rock. It was also ascertained that sufficient reinforcing steel could be obtained to build at least 600-ft. of the wharf as now planned. Future extensions beyond the rock area could also be designed in the usual type of piled wharf and the layout of the reclamation walling allowed room for building an apron 50-ft. wide.

The general design considerations allowed for a surcharge of 5 cwt./sq. ft. and for rail track concentrations. The weight of selected sand filling was about 110 lb./cu. ft. having an angle of repose equal to 30°. Toe pressures on the base were about 4 ton/sq. ft. and tests on the outer end where a pocket of sandy silt was found, indicated that this would require removal and replacing with a fill of clean sand and rubble.

The design of the caissons was analysed by Hardy Cross methods. Concrete stresses were 850 lb./sq. in and 1,000 lb./sq. in for in situ and launching moments, and steel, 18,000 and 20,000 lb./sq. in All concrete was specified for a minimum crushing strength of 3,000 lb./sq. in. at 28 days with special regard for density and watertightness. The usual calculations were made for stability during flotation and sinking. As a further check on the behaviour of the caissons during launching and sinking, a scale model in concrete was made and reference to this will be made later.

Bollard pulls on the caissons were taken as 80 tons horizontally and at right angles to the wharf face. Fendering was designed in hardwood and of a spring type to allow deflection under berthing blows. Rubber blocks were considered in conjunction with the timber but were not gone on with owing to the uncertainty of delivery at that time. A service tunnel was incorporated with the deck superstructure, and electric power, telephone and water were supplied through this to outlet boxes in the kerbing. Drainage of the rear filling was also arranged at half-tide level, and surface water was discharged beneath the service tunnel. Manholes provided for access to this tunnel, and electric lights gave illumination for inspection and maintenance. Cast steel bollards of a special heavy design were set at approximately 50-ft.



View of caisson looking at top of diaphragms.

Wharf Extensions at Devonport, Tasmania—continued

centres and a reinforced concrete kerb with rounded steel corner protection ran the full length of the wharf.

The final design allowed for the dimensions of each caisson to be 90-ft. long by 30-ft. wide at the base and 48-ft. high. Each contained at launching about 850 cu. yd. of concrete and 110 tons of steel reinforcing, giving a deadweight of approximately 1,530 tons. Subsequent measurements on floating showed this to be about 1,560 tons. The designed draft at launching was 26-ft. 6-in. and sinking at a maximum of 32-ft. Actual floating out draft varied from 26-ft. 8-in. to 27-ft. 3-in. By one of those strange upsets in construction work around a harbour front, No. 1 caisson, on which so much depended, was finally sunk with a draft of 40-ft. in a storm which arose with extraordinary suddenness. However, the extra high stresses on the shell did not cause any trouble and it was with a sigh of relief from all concerned that the caisson performed a copy-book roll on taking the ground. The rest of the caisson sinkings caused no further excitement.

The caissons were built on their sides, that is, on the future wharf face. This slab was 16-in. thick and it was necessary to fit the flooding valves in during construction. Bolt holes and anchors for attaching the fendering were also carefully built in and fitted with wooden plugs for protection. Very heavy haunching was used in the end bays to resist the launching and floating stresses. As the caissons would be finally seated on a level rubble bed, 2-in. diameter grout pipes were fitted in the bottom slab (rear vertical wall during construction) and plugged with soft pine which could be driven out after sinking.

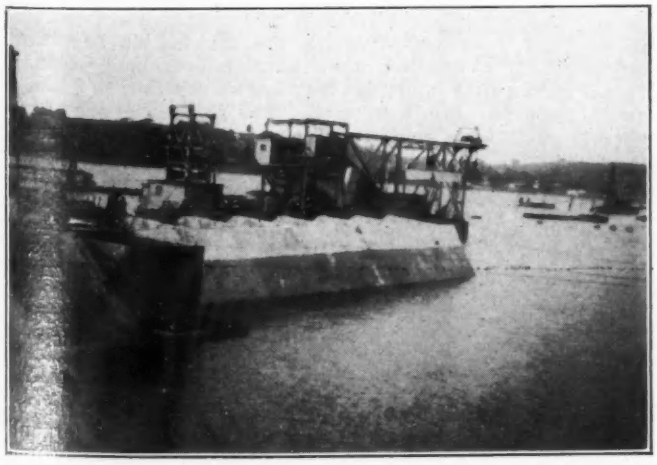
Construction Yard

Having settled on the proposal to use R.C. pontoon caissons, the question of being able to build and launch such heavy weights became a primary consideration. At this time, dredging and reclamation were in full swing and several sites seemed possible, allowing a free entry into deep water. As the caissons would be built close to the edge of the bank and their launching weights would be about 1,530 tons, care had to be exercised that they would not slide or move prematurely. Temporary wooden piles were driven at 4-ft. centres and a heavy scrub retaining wall was built from low water to a R.L. of about 13-ft. or 3-ft. above H.W.O.S.T. to enclose an area of about two acres. Coarse sand and shell was pumped in and levelled with a bulldozer which at the same time consolidated the surface to receive the first slabs and falsework.

This operation was to cause no end of anxiety later during actual launching. An area for precasting concrete units, assembling boxing and fabricating steel was also prepared. Tool sheds, etc., were placed handy to the actual building site. At the rear of this area the main reclamation had been filled behind a retaining wall to a level of +20-ft. above low water providing a vertical step of about 7-ft.

This allowed the storing of all aggregates and cement on the upper level in large bins, and these materials were transported to the mixer by a 30-in. wide conveyor belt through volume measuring chutes. The gravel and sand bins held 500 cu. yd. and the cement store, 50 tons. The concrete plant worked without a hitch and manufactured over 10,000 cu. yd. for the wharf and ancillary works. A ½ cu. yd. electrically-operated drum mixer was erected on the lower level and was fitted with an automatic water feed and a dispensing arrangement for the entraining agent.

Part of finished wharf in foreground —caisson being sunk at rear.



Caisson being sunk in wharf line; 16-in. reclamation dredger at rear.

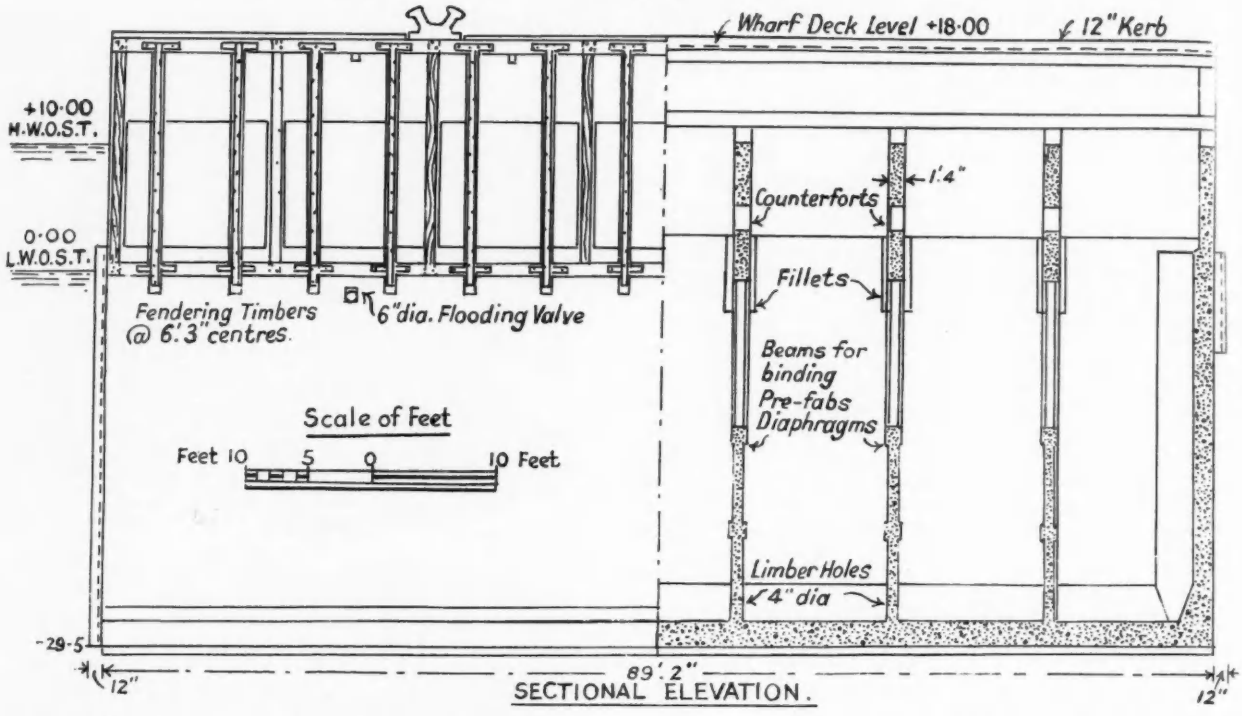
The cement shed was erected over the mixing plant and the cement chute discharged straight into the mixing drum. On completion of mixing, the charge was emptied into a 1 cu. yd. hoist and elevated to a receiving hopper for the transport equipment which consisted of a 1 cu. yd. bucket on a two ton hydraulic crane jib and a ½ cu. yd. motor barrow. In this way an output of 12 cu. yd./hr. of finished concrete was easily dealt with. Records of each batch were kept and test cylinders were made. Tests of moisture content of the aggregates were made twice a day and the water/cement ratio calculated for the morning and afternoon pours. The test cylinders averaged round 4,000 lb./sq. in at 28 days and a very dense concrete was made from the local river shingle and sand deposits, combined with 10% to 12% of crusher grits. A slump test was taken periodically and this was not allowed to exceed 2½-in. at the site.

Workshops were erected on the upper level and these housed a fully equipped machine shop, carpenters' shop, steel store and fabricating shop. Welders were provided with 30 amp. plugs all round the job and they used these to advantage.

A vertical bar bender was fabricated out of a gear wheel, gearbox and 7½ h.p. motor. This was fitted with automatic cut-out and reversing switches and one man handled over 1,000 tons of steel without any trouble during the course of the work. A hydraulic press was also rigged up for pressing out the cranked bars and several thousand were made on this machine, all to the same size and shape. A bar cropper was also motorized from a manual guillotine.

Jigs were set up for fabricating the slab reinforcement into large mats and these sometimes reached a weight of 2 tons. By

Wharf Extensions at Devonport, Tasmania—continued



General arrangement of wharf caisson.

using welding extensively, they were easily handled by the cranes and suffered no deformation in placing.

Boxing was made up with heavy timbers and for certain work, 14 gauge corrugated steels were screwed and bolted to heavy timber frames. These were used many times over and proved most efficient.

Elevating towers with power winches, skips and light rail tracks were made up in steel to transport the concrete when placing at a height. Hand barrows on pneumatic tyres were also used for the more difficult parts of the job. The falsework was built out of substantial timbers and bolted together. It was thus possible to deal with 6-ft. to 8-ft. lifts involving the pouring of over 100 to 150 cu. yd. of concrete in one operation.

Building the Caisson Units

The area was laid out for constructing five units (four were finally built and joined by special plug units to compensate partly, for the loss of length). The units were built on their sides so that the final wharf face was on the ground and this formed the first slab to be poured. The 3-ft. toe was formed in the ground on a thin precast slab. The sand was levelled and a thin lightly reinforced concrete slab poured in panels so as to facilitate stripping on launching. The main reinforcement was fabricated with wall and diaphragm starter rods in position. As the diaphragm panels of No. 1 caisson were precast, means of making a joint with the main steel was allowed for so that the rods were in correct sequence for joining by welding. Pouring proceeded until the roof was reached when shuttering was bolted to the walls already built.

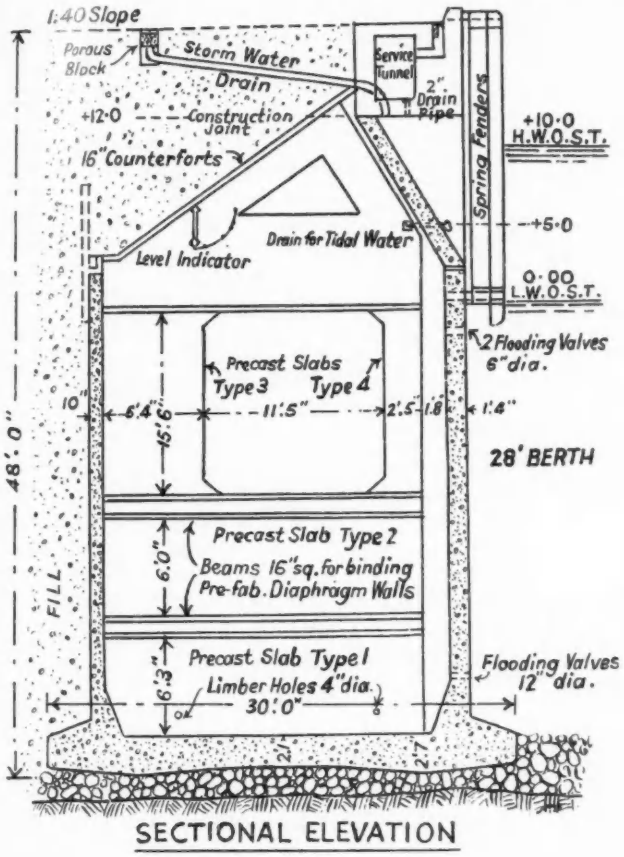
Experience with the first caisson suggested several improvements and it was resolved to cast the main diaphragm slabs in precast units on top of the ground slabs and fitted with special hinges formed in line with their final haunching. They weighed 32 tons each and, at the time of casting, bolts were cored through the slabs to secure the steel girders which formed the lifting harness. The slabs were given four to six days to cure, using ordinary cement, and were then lifted into position using a jumbo rig. The steel which was left protruding was then welded to the bottom slab and rear wall steel, which eventually formed the bottom of the caisson. The counterforts were also fabricated and jointed to the front sloping wall. Steel was left protruding to junction with the superstructure.

The actual lift was done by the winch on the large pile driver and the total time occupied in lifting a slab was about one hour. Once plumbed and shored, the hinges were removed and the next slab commenced in the adjacent bay. In this way the six internal diaphragm slabs were erected in about 6 to 7 weeks. Meanwhile the outer steel and formwork were proceeding and pouring of the concrete again followed until the roof was reached. As the handling and removing of heavy shuttering nearly 30-ft. in the air was most difficult with primitive crane equipment, 2½-in. thick precast reinforced concrete slabs were made and erected on special light wooden trusses set on wedges supported on walings bolted to the top of the diaphragm slabs.

These trusses were easily removed and were used for all remaining caissons roofs. Wherever possible, the steel reinforcement was designed to be placed in large sections and, as already mentioned, they were built in the workshops on special jigs and welded into rigid units for transport. It was thus possible for the carpenters to follow up very closely behind the steel erectors when these large mats were fixed in their final position. The whole of the concrete was vibrated with high frequency internal air vibrators. Pattern vibration was insisted on to prevent segregation and to ensure a dense concrete throughout. Shuttering was moved at 48 hours and followed up generally in 6-ft. lifts, though some 8-ft. lifts were used. The surfaces of the poured concrete joints were scuffed at 6 to 8 hours with a compressed air and high pressure water blast, and, before the succeeding pour was placed, again given a clean down with compressed air jets.

Any porous or doubtful concrete showing when stripped was chipped out with air chisels and thoroughly cleaned. A special gunite gun was manufactured, and used a mixture of dry sand and cement which was hydrated at the time of application and blown on at high pressure to make a perfect union with the original concrete. A sealing wash was given to the patches to retard drying out and prevent differential shrinkage. This work proved most successful and no signs of porosity were recorded later at the time of launching. All concrete was kept wet for at least 10 days by the use of " soakit " hoses and garden sprinklers. Wet sand was also used on certain portions. A large tarpaulin covering half of the caisson was always kept in readiness should rain or high winds interfere with the work.

Wharf Extensions at Devonport, Tasmania—continued



It was possible to pay tribute to the construction staff on the excellent concrete produced throughout, as not one leak developed on floating out, even when the concrete in No. 1 caisson was subsequently subjected to a head of 40-ft. of water.

A special brass pivot attachment for holding the lining up gear on the caissons during sinking and final placing was made and fitted to the outer ends of the toe sections. In this position, the floats and wires were clear of all obstructions.

Construction of Approach Section to No. 1 Caisson

A triangular section was constructed to link up the caissons with the existing wharf, this length being 160-ft. long by 50-ft. wide at the outer end. Wooden piles and caps, precast concrete beams and in situ concrete deck made up the components. The whole was joined to the old wharf face at the rear by heavy steel splice plates and tie bolts. All piles were driven home to the rock, the face piles having only a shallow grip in the boulder clay but sufficient to enable them to stand on their own after driving. A special 6-ton chisel was made to assist in "potting" the piles, but only one gave trouble and this was finally re-located in a clay pocket in the rock-bed.

To retain the dredge fill behind the first caisson and the end of this section, a steel sheet-pile cut-off wall was driven to rock, and a rubble fill interspersed with a number of concrete blocks was placed on both sides of the piling to enable it to withstand the pressures. A slight movement took place later during reclamation, but this was mainly due to the sand-fill rising faster than the rock-fill, as both jobs were going on together. It was also the intention to grout the rock-fill, but for various reasons it was omitted. However, in similar circumstances, such grouting would be a wise and proper precaution against movement where the toe grip of the sheet piling is rather precarious.

All services were laid under the wharf, and rail grooves were cast for placing the main tracks to junction with the old wharf system and the new work on the caissons. Fenders and bollards were fixed in the usual way.

Joining the Caissons

The original intention to place the caissons close together and fill the gap with concrete was abandoned when only four caissons were built. Sixteen special plug units each 24-ft. x 14-ft. x 8-ft. fabricated from precast concrete slabs were prepared on the Board's 500-ton slipway and lifted off on steel pontoons for setting with a floating crane. These units provided about 60-ft. of wharf face to replace the loss of one caisson unit measuring 90-ft. long. A heavy dolphin was also built clear of the last caisson, making up the balance of the 70-ft. length and retoring the 650-ft. of berthage.

Dredging and Preparing the Foundations

As already stated, the depth to rock varied from −28-ft. to −32-ft. below L.W.O.S.T. In order to obtain space for seating the caissons on a rubble mattress, and to remove the rock pinnacles, the bucket dredge was brought in to clean up the area. This operation was very slow and difficult but eventually a least depth of −29-ft. was obtained and all clay was cleaned off to bare rock. Small angular rubble was obtained and barged to the site and shovelled off.

A large screed of three 24-in. x 7½-in. R.S.J.'s 40-ft. long fitted with a row of steel teeth like a rake was suspended from the large pile-driver barge and towed up and down the length of each caisson position until grid soundings showed the base was nearly level. A final dressing of small crushed rock was then given and screeded with the plain R.S.J.'s on their own. In this way levels within an inch were obtained. Examination by the diver showed the base to be equal to a well-prepared road bed.

Launching the Caissons

With all foundation preparations completed, the launching stage of the job came next. The reclamation dredger was brought into position and, after removal of the scrub walling, and temporary piling, undermining of the two front caissons was commenced. A few hours of heavy cutting into the toe failed to disturb the main fill and the dredge was pushed ahead until only 100-ft. from the towering masses of concrete. Only a few signs of the sand being weakened were evident at this stage, when the bank collapsed suddenly and the first caisson took its initial slide and ended up with one end in deep water and the other still on the bank. The sand continued to run out from under the caisson for some hours after and in the meantime the next caisson decided to follow.

The sand running out from the centre section of each caisson was a most spectacular sight but gave rise to considerable anxiety. It was then realized that the packing of the upper layers of sand had formed a crust, and the fact that the sand had been pumped and washed clean of all binding silt material also provided a veritable quicksand. This spontaneous loss of sheer strength on disturbance is a well-known phenomenon and it was apparent that the caissons would practically launch themselves provided enough clearance in front was provided.

This technique proved most successful and it was found possible to move the caissons almost at will by the judicious use of the dredger and undercutting the frontal section of bank with air and water jetting. As each caisson was floated out, it was towed to its site and prepared for holding in position and final sinking.

Sinking the Caissons

The last operation and probably the most interesting phase of the whole work was now reached. Model tests had been carried out and these showed the caisson to be perfectly well-behaved, provided the critical righting angle was passed through with the toe clear of the ground. It was also found that time must be given for the water to fill all compartments equally, to prevent the caisson taking a swing out of line at the time of grounding.

The caissons were fitted out with six winching points, two on each side and one fore and aft. The winches were manned under the control of a foreman who directed all operations, including

Wharf Extensions at Devonport, Tasmania—continued

the operation of the flooding valves. The toes of the caisson were fitted with flexible steel wires, running from two special buoys carrying steel pointers, to the brass pivots previously mentioned. A plumb-bob was fixed to the newly constructed section and lined in with a theodolite. The outer end of each caisson was kept under control by an instrument man on another theodolite on land some 900-ft. away and, by using hand signals, he kept the steel pointer on a pre-determined line.

In this way, at high water, each caisson was slowly sunk by the inflow of ballast water and pulled into position by the winches until an angle of 80° to the vertical was reached. About 800 tons of water were required to bring the caisson to this position and, on touching the ground on a falling tide, all valves were fully opened. Sinking was then completed in about 20 minutes, the final filling resembling a miniature Niagara. Once in position, levels and alignment were checked. Grouting the base was then commenced and carried on until completion.

When all caissons were in place, the dredger was brought in and each grouted caisson filled with sand up to the level of the rear wall. No difficulties were experienced and no settlement was recorded, indicating that the base rock was well consolidated.

In the meantime, the boxing for the superstructure and service tunnel was erected and the concrete work completed to finished deck level. A rail groove for a future crane was cast in the top slab.

Fendering and Services

The wooden spring fendering was finally fitted on the main counterforts and upper deck face, irregularities in the alignment being taken care of at this stage. This did not amount to more than 3 or 4-in. at any one point. Bollards were fitted, also electric power plugs, water hydrants and telephone jacks.

Reclamation at the rear of the structure was in progress when the author left the employ of the Board and this has now been completed. A cargo shed 400-ft. long by 80-ft. wide has also been erected, together with railway and road connections.

Conclusion

The finished work presents quite a pleasing appearance when viewed from the swinging basin but the main caissons and their junction units lie buried under many thousands of tons of sand fill, giving no indication of their having been built on dry land prior to their launching and sinking in their final position.

No attempt has been made to include any calculations in the paper, it being felt that the construction of these units is of more general interest. There appears to be very little information on the actual construction and launching of large caissons in locations where no dry dock facilities are available. The methods used, however, were found to be quite effective, provided the construction staff were well versed in each operation prior to its being carried out.

Book Reviews

"The Modern Port." By H. Fugl-Meyer. Published by the Danish Technical Press, Copenhagen V, Denmark. Price D.cr. 22.50.

During recent years the problems of cargo handling have often been ventilated in technical articles and in discussion groups. This book is an attempt to produce a combined technical and practical description of all the problems concerning cargo handling at ports and to suggest to engineers and port executives methods of improving details likely to affect the general flow of cargo.

The book is intended to be a compendium for all interested in harbour problems and has, in fact, been designed to be used as a text book in the Norwegian and Danish technical colleges. It deals with all phases of the handling, transportation and storage of goods as well as with the equipment and buildings necessary for the efficiency of the modern port. Wherever possible, plans, cross sections and illustrative examples are given, and there is a chapter devoted to passenger facilities. Another chapter deals with time studies, in which observations from the author's own experience are discussed and the latest papers on the subject reviewed. The appendix gives a crane specification which should be quite useful.

On the whole, the book bears witness to the author's wide experience of ports throughout the world and will be valuable for design engineers as well as for port operators.

"Electric Cranes" (Third Edition) by H. H. Broughton, M.I.C.E., M.I.Mech.E., E.M.I.E.E. Published by E. & F. M. Spon Ltd., 23 Gt. Smith Street, London, S.W.1. Price £7 10s.

Mr. H. H. Broughton's work "Electric Cranes" first published in 1911 and revised in 1922, has been acknowledged since its inception as the most authoritative reference book on this subject by a British Engineer. The third edition of this comprehensive volume, eagerly awaited by those who knew of its creation, has now been published.

The word "creation" is employed deliberately, as progress since the revision in 1922 has been so extensive that anything but a complete reconstruction was considered to be quite inadequate.

As it is, the Author has been forced carefully to prune much available data, but the volume as now presented contains an invaluable fund of information for both designer and user alike. It will be observed that in his new work he has increased the proportion of pure design, and that each section of the crane structure and machinery is given full consideration.

To the designer, Mr. Broughton's long and close association with the British Standards Institution will be apparent, particularly in regard to the classification of Cranes into groups according to their operational hours per year, and the calculation of permissible stresses based on these, and other conditions of service. One may regret the summary dismissal of the Factor of Safety on which basis so many robust cranes were designed in the past, but obviously with more scientific methods available for recording stresses, the application of information thus obtained must result in economy in materials and in greater advantage in the foreign markets. Dare one hope that eventually the Home Market will also benefit?

The chapter dealing and analysing the stresses for which allowance is made, is most informative, and obviously much research has been carried out in obtaining the stress factor covering calculable stresses for the various classes of cranes. The operator however will note that although the effect of impact is dealt with separately, and Hoisting Impact Factors suggested, it is assumed that the crane will be handled in a gentle fashion. The allowance for operating to present day working standards is left to the discretion, and presumably the past experience, of the designer, and in this respect one wonders whether if perhaps under different guise the almost defunct Factor of Safety will still leave its influence.

Onwards from this new approach each component of the crane is considered in logical sequence, Bridge Girders, Gantries and Jibs on the structural side and every component part in turn on the mechanical side, thence to electrical equipment and to a final summing up with examples of particular types of cranes.

It would be impossible without a long period of close study to glean the full import of the design work combined with practical application and guidance, and therefore only generalisation is practicable at this stage.

To the user the chapter devoted to Wire Ropes, and Chains and Slings will be of outstanding interest and assistance, as will be the one dealing with Mechanical Brakes, all of which are of such paramount importance on the operating side.

On the subject of Spur and Helical Gearing one is gratified to see that a more realistic approach to rating is being made, in that Life Factors for strength and wear, and an Application Factor depending on the particular duty are introduced.

The Author in his Preface leads one to suppose that the Electrical Section is of an elementary nature but in fact the five chapters devoted to this subject contain a more than adequate proportion of theory of motors and forms of control which in

Book Reviews—continued

conjunction with the excellent diagrams reveal to the user—and perhaps indeed to the Crane designer—the complexities of the electrical equipment in the modern crane.

All will be in complete agreement with the suggested need for standardisation of crane motors, and for close consideration of the actual duty in deciding the rating for the hoist motion. One would suggest that particular attention should be paid to the calculations required for the other motions as indicated by the Author. The old and somewhat rough and ready formulae, particularly for slewing and travelling motions, which have served satisfactorily over the years for D.C. Motors are apt to prove inadequate where A.C. motors are employed.

The conclusion to which the user may come when he has considered the various means employed in endeavouring to provide D.C. series motor characteristics to an induction motor, is that it may well be more economic and less complicated to employ a D.C. motor with suitable means of rectification, for the hoisting motion, or a commutator motor.

The final chapters are devoted to the multiple applications both at home and abroad of Overhead Travelling Cranes, Jib Cranes which include those employed on general and bulk cargo work, Bulk Unloaders and Grabbing Cranes and Fitting Out, including Floating Cranes. Each chapter contains valuable guidance in regard to construction, capacities, speeds and types of control which is augmented by clear and concise tables.

Throughout the work one is impressed and aided by the eminently practical approach to all the problems and information with which the Author deals so expertly. If further information is sought reference to other Authorities is made at the conclusion of each chapter—a most helpful adjunct.

The study of this volume by both designer and operator will bring about the realisation that here again is the complete reference book on Electric Cranes—a worthy successor to Mr. Broughton's previous work.

The Geneva Code for Safe Working in the Docks

We have in the United Kingdom become familiar with the Docks Regulations (S.R. and O. 279 of 1934). For 24 years " the processes of loading, unloading, moving and handling goods in, on, or at any dock, wharf or quay and the processes of loading, unloading and coaling any ship in any dock harbour or canal " have been carried out in accordance with its provisions. The six parts into which it is divided determine the responsibility of the parties who take a hand in these processes. Port Authorities and owners of docks are told in Part I what they must do, shipowners follow in Part II, owners of plant used, in Part III, and employers of labour in Part IV. In case any of these should fail in their duties, Parts V and VI clamp down on them collectively. In the preamble and the 51 paragraphs that follow, the physical conditions in the docks for safe work, the daily precautions to be observed in or on the ship, the care and testing of machinery on the quays and in the warehouses are set out in language that can be understood as clearly in the holds of a ship as in the Courts.

The ports occupy a unique position in industry, and one for which the drafting of safety regulations has peculiar difficulties.

Unlike the factory with its stable conditions of plant and labour, the 1,250 employers (approximately) who are registered with the National Dock Labour Board do not own the premises where labour under their control is at work. It is true that port authorities own quay installations, but they do not own ships; shipping companies own ships but not the quay premises through which the cargo passes. Some of the larger employers own machinery. Many of the smaller ones own but a few rope slings.

The Docks Regulations were made equally for the ship that bristles with the latest cargo handling gear and for the coal burning tub, 70 years old, with "sticks" and winches that threaten to collapse under the strain of lifting a few hundredweight of softwood from the Baltic. Whilst the larger employers have a nucleus of permanent men, others, and these form the bulk, work with men supplied to them by the National Dock Labour Board. Supervision on the foremen and the gang level, which is the level on which ultimate responsibility for the observance of safety regulations rests, rarely remains constant. Today's ganger may be in the hold tomorrow, or working with an entirely different gang in another dock.

Many years of familiarity with Docks Regulations have sufficed to overcome the very real difficulties of enforcement. It is not however to the gang level that governments can look for improvement in safety legislation. An illuminating word in the 1934 regulations is " coaling " ; even without the year in its title the S.R. and O. is dated.

Since 1946 a silent revolution has swept the ports of this country. Between the two wars, save for the introduction of the electric truck and certain bulk handling machinery and a great improvement in quay cranes, there was little development to disturb what was described as " a paradise for hand-trucks." Now forklift trucks, mobile cranes, tractors and trailers, including a variety of mechanically operated trucks and haulage units, have been introduced by the employers and accepted by labour. With them has come an entirely new type of dock shed and warehouse, made necessary before the unique powers of the new machinery could be exploited.

Although familiar with the 1934 regulations, operating officers embarked light heartedly on the uncharted sea of the early and somewhat primitive mechanisation. As the machines grew more complex, which they speedily did under the pressure of the demand for special commodity use, so users found themselves faced with problems of safe working for which their old companion, 279 of 1934, could give little help. The stability of the forklift truck, both static and dynamic, drivers' visibility, the safe angle of tilt on shed floors which had a pronounced drainage slope, these were but a few of the problems that quickly obtruded. With mobile cranes the principle of the loss of capacity as the jib luffed down, revolutionary to a generation of quay crane drivers, the type of surface they operated over, the air pressure in the tyres—there were many accidents, some involving personal injuries, before the behaviour of the new equipment was mastered. Many enlightened employers produced their own standing orders for their crane or truck drivers. Whilst these had no legislative force they were valuable as incorporating the conclusions drawn from the experience then available.

Formation of International Safety Committee

This independent action was paralleled by international activity. Twelve nations sent representatives to the " Meetings of Experts on Safety and Health in Dock Work " which assembled at Geneva in April 1954, under the auspices of I.L.O. In addition, there were delegates from the World Health Organisation, the International Shipping Federation and the Belgian Transport Workers Union. The first decision reached re-established the Convention, No. 32 of 1932 (from which our own Docks Regulations stemmed). It was decided not to expand or to revise this convention, but that it should be supplemented by a code of practice to be drafted by I.L.O., assisted by the experts. By December 1956 the Geneva Code of Practice (as it has become known) was born. It contains 689 paragraphs and is a " body of advice for the guidance of all those who have some responsibility in the promotion of occupational safety and health in dock work . . . . its value will reside in the fact that it is the work of experts and embodies the knowledge and experience of many countries." Nobody who has given the Code the careful attention that it certainly merits will quarrel with the above.

Resulting from a scrutiny of the relevant paragraphs it is, firstly, apparent that each of the parts of S.R. and O. 279/1934, and with very few exceptions each of the paragraphs contained therein, have been treated by the experts with painstaking care. Take, for instance, Docks Regulations Nos. 13/16. These deal tersely with hatch covers and beams. In the Code the relevant chapter is No. 9, " Opening and closing hatches " ; Section A deals with

The Geneva Code for Safe Working in the Docks—continued

the "Construction and maintenance of Hatch Covers and Beams" and Section B with "Handling of Covers and Beams." The 19 lines of the Regulations serve as the text for a constructive sermon of 21 paragraphs in three pages. None of the material is tautological; each sentence contains a carefully thought out warning against practices which the ship operator knows only too well are prevalent. Part IV of the Regulations, for example, infers that the practice of piling hatch covers against the coaming is to be deprecated. Part II (paragraph 17) refers to the importance of working space around a hatch being at least 2-ft. wide; the practice of piling covers tight up against the hatch coaming obviously contravenes this. In the Code, paragraphs 356/360 describe explicitly not only how hatches should be treated, but also includes that fruitful source of accidents, loose beams sprawled across a sloping deck. There is hardly a Regulation that cannot be laid against its correspondingly amplified section of the Code.

Not content with this the experts have allowed their scrutiny to rest on such practices inherent in ship work as (inter-alia) winch-end work, the rigging of derricks, derrick spans and arrangements for the safe working of the union purchase. The cranes on the quay have received a full share of attention. To those who, before the general use of electric cranes in which the incorporation of a heating unit became standard practice, have wrestled with the problem of heating crane cabs, paragraph 254 has an ironic ring, "During cold weather the cabs should, where necessary, be adequately heated by suitable means." Making up sets, dragging out from the wings, piling goods safely on the quays and in warehouses and storage places are among the subjects which have been exhaustively studied. The weight of expert opinion is such that no dissent from these recommendations is possible on practical grounds. Bulk cargoes discharged by conveyors, magnets or grabs come in for attention as do dangerous and hazardous shipments.

Provision of Welfare Facilities for Dockers

To inspect a century old plan of a dock is to note immediately the entire absence of buildings devoted to amenities for dock workers. It is true that the position of the few latrines provided may be indicated, but little imagination is needed to picture the low standard that found ready acceptance from public opinion in those days. Wartime demolition enabled many port authorities to install sanitary arrangements that compare most favourably with municipal facilities. In many instances the standard is higher than that provided by private enterprise outside. An adequate supply of drinking water, cloakrooms and washing facilities is being accepted in many ports as a necessity. The standard of port catering arrangements is immensely superior to many of the coffee-shops that satisfied an earlier generation of dock workers. Training in first-aid has enabled immediate attention to be given to minor injuries.

It is natural to find that the Code has much to say on these developments. Part I of the Regulations dismisses the subject in regulations 2 and 4; the rescue of drowning persons and the provision of first-aid boxes. The Code devotes, in Chapters XV and XVI, 76 paragraphs of recommendations which include the overdue provision of suitable small boats and landing places for ship men required to work on vessels in the stream. Hiring halls and rooms used by men waiting to be taken on are recommended, although the known preference of some men to assemble at draughty street corners rather than to use amenities within the dock estate is not commented upon.

And how does the Code tackle the more modern equipment that looms so largely in the U.K. port picture? When using fork-lift trucks in the 'tween decks of holds, regard should be paid to the weight bearing capacity of hatch covers. Later, in paragraph 582, it is recommended that where the internal combustion engine is the source of power, the operator should not be allowed to work in a hold alone. There should be no harmful concentration of gases, and where necessary, additional ventilation must be introduced. The many problems of dynamic stability of power driven trucks are treated in 21 paragraphs (460-480) and these include useful suggestions for a system of one-way or circular traffic, the need for sound and even surfaces whilst working in the open, and the regulation of aisles and gangways in buildings; physical features to be avoided are sharp turns and corners, steep inclines and ramps, narrow passageways and low ceilings.

Mobile cranes are not given as much attention as they deserve. The need for tables indicating the maximum S.W.L. for the various inclinations of the jib, to be displayed at suitable places, is urged, as is the fitting of automatic radius indicators. Trackless mobile cranes are dismissed in one paragraph, No. 266. This makes the obvious recommendation that they should not be used on a soft or uneven surface or on a slope "unless their stability is assured."

It may be cavilling at a monumental work of research to remark on the absence of recommendations to the more modern forms of cargo handling. For containers and container ships, self discharging bulk carriers, mechanised ships which include lifts and self-propelled cranes, the roll on—roll off vessels whose number is growing annually, we shall presumably have to wait. In fairness to the group of experts it must be said that there is very little experience on which to base recommendations. Few, probably, of the national delegations could confess to having practical experience of these vessels whose operations have largely been confined to local traffic routes, where suitable terminal facilities are to be found. They have naturally attracted much publicity but port operators and shipping companies will still be thinking in terms of the hook and its load long after the Geneva Code has, in the legislative form it will ultimately assume, replaced the Docks Regulations of 1934.

Correspondence

To the Editor of "The Dock and Harbour Authority."

Dear Sir,

Marine Surveying at the Port of Newcastle

A reply to Mr. Margrett's helpful letter in your March issue referring to the above article seems to be apposite.

I agree with his suggestion in paragraph 1, the essential being, of course, the callibration of the sub-tense board.

On the question of slope errors, I can only quote from experience. In an experiment the launch was moored with the oscillators vertically over the foot of a steep slope. Using the least sensitivity, a sounding error was recorded which, on measurement, indicated a lobe echo 7½° from the vertical, or a 15° polar beam spread. I did not, however, wish to infer that this angle was a constant for all conditions.

The problem of silt in suspension is more vexed. Here also I can only quote from practice. When sounding a dredged basin behind coal staiths, using only a slight sensitivity, a difference between hand and echo sounding varying from 0 to 2-in. was observed, errors occurring not only alongside staiths but in the dredged area where there could be no interference from side echoes. Accordingly, a bar check was made in the basin which gave correct readings until it reached a distance off the bottom of about 15-in., when its echo was obliterated by what can only be presumed to be heavy silt in suspension.

Alteration to the decay and voltage controls was advised, and carried out, by Messrs. Kelvin Hughes and has resulted in an improvement when sounding in such conditions. It would perhaps have been wise to have added in my article that such adjustments should be made only in consultation with the makers.

Finally, all surveyors will have welcomed Mr. Margrett's letter and the information he gave. Might I suggest that Messrs. Kelvin Hughes could collate such information for the benefit of all users.

Tyne Improvement Commission, Yours truly,
Bewick Street, Newcastle-upon-Tyne. D. McCLEAN.
31st March 1958.

A Search For Optimum Container Size

Report of Recent Study in U.S.A.

A paper with this title was presented by a British Army officer, Major H. A. Ablett, M.B.E., at the 1958 Symposium of the Maritime Cargo Transportation Conference, Washington, U.S.A. In introducing his paper, Major Ablett explained that a study had recently been conducted by the U.S. Army Transportation Research and Engineering Command to determine the sizes and configuration of general cargo containers which will most effectively meet the requirements of the Transportation Corps in world-wide service. The purpose of the present discussion, he added, was to outline the method which was used in an attempt to provide the answer to this problem.

The use of containers, he went on, is not, as is often supposed, a contemporary idea. History shows that as early as 1801, the basis of a container system was conceived. There is no record that this original idea was put into operation at that time, but by the mid-nineteenth century, container systems were instituted both in the United States and Great Britain.

In recent years the use of containers has expanded rapidly throughout the world and has now become an important feature in commercial and military transportation.

The basic advantages which cargo containers offer are:

1. A reduction of man-hours in handling and checking.
2. A reduction in weather damage.
3. A reduction in pilferage.
4. A reduction in packing and crating materials.

Many containers have been developed to carry only a particular commodity; for example, the military Conex container (Fig. 1) was originally procured to transport the household goods of Armed Forces personnel moving overseas. However, the realisation of the potential of containerisation has led to the demand for a general-purpose cargo container.

Military logistic planners in the Transportation Corps realised this need some years ago, and the household-goods container was taken into use for the transportation of a great variety of military supplies. The experience gained in these operations over a period of years has confirmed the expectation that containerisation of certain types of general cargo could lead to great savings in manpower, time, and money.

Once the economic advantages of containerising general cargo were established, the logical progression of research called for the establishment of the ideal size of a container or containers.

Outline of Basic Factors

The first step in the study was to consider, in outline, the factors which must always influence the selection of the configuration of a container designed to carry miscellaneous cargo. The principle considerations are as follows:

1. **Capacity.** The efficiency rating of a container, in isolation from all other considerations, is based on three ratios: the ratio of internal cube to external cube, the ratio of tare weight to capacity, and the ratio of cost to capacity. The larger the container, within reason, the more efficient it is on this basis; and it follows that, if all other considerations are rejected, the container should be as large as possible in order to secure maximum efficiency.

2. **Dimensions of Cargo Floors in Transportation Media.** The horizontal dimensions of a container should be fixed so that it is possible to carry the container on all forms of transport likely to be encountered and so that maximum utilisation of available area on the cargo bed can be achieved. The problem will vary in complexity according to the types of transport which have to be considered.

3. **Available Overhead Clearance.** The vertical component should be set so that maximum advantage can be taken of available overhead clearance between the cargo platform and fixed overhead obstructions, that is, either roofs, bridges, or hatch beams. Frequently the various carriers used offer wide variation of vertical clearances. If a container family is to be used, its components must be capable of tiering in such a way as to provide variable vertical dimensions so that available cube can be fully utilised. If only one size of container is used, the vertical dimension must be set so that undue waste of vertical space can be avoided.

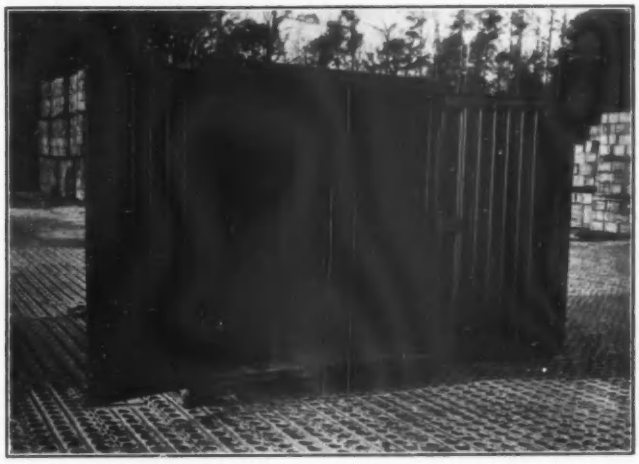


Fig. 1.

4. **Internal Cube as Related to the Maximum Permissible Gross Weight.** The available internal cube in any container should be suitable for the density of the cargo to be loaded. It is, of course, impossible to achieve absolute efficiency in filling containers because of the variations in density of cargo. However, it can be readily appreciated that, unless the desirable length, width, and height are considered together with the requirement of internal cube, such advantages as might be secured by particular external dimensions might very quickly be lost because of unsuitable internal cube. For example, in a case where the considerations of desirable length, width, and height result in the design of a container with a usable internal cube of 300 cubic feet and where a gross weight limit of 10,000 pounds is imposed, the density of the cargo would have to be 28 pounds per cubic foot to permit fully efficient loading. If the cargo to be loaded possesses a density of 40 pounds per cubic foot, the gross weight of the container could amount to 13,500 pounds (an overload of approximately 33 per cent.). On the other hand, if the gross weight limit is observed, approximately 30 per cent. of the internal cube would be unoccupied.

5. **Consideration of Handling Facilities.** The gross weight limit of the container should be based on the capacity of the materials handling equipment which is generally available at transfer points. The size of containers will necessitate the use of mechanical handling equipment at transfer points. Consequently, the capacity of such equipment already in the transportation system should dictate the establishment of the permissible gross weight of the container unless mechanical handling equipment of greater capacity is substituted.

6. **Operational Interest.** So far as military container programme is concerned, the requirements of the transportation system must provide the primary influence on the configuration of containers. Nevertheless, great care must be taken to ensure that any new configuration does not create major problems for the shipper.

Outline of the Plan for Analysis

A study of the basic factors which influence container design indicates that it is a complex problem and that the possibility of producing a container or a family of containers which will provide ideal utilisation on any and all forms of transport is remote. The best that can be hoped for is an end product which offers the optimum compromise.

The study was divided into segments as indicated by the basic

A Search for Optimum Container Size—continued

factors which have been discussed. The following outline was finally chosen for the study.

1. Detailed consideration of factors affecting design.

(a) Weight factors, including the following:
   (1) Payload of carriers.
   (2) Lifting capacity of ship's gear, quay cranes, crawler cranes, fork-lift trucks, and rough-terrain equipment.
   (3) Capacity of aerial tramways.
   (4) Limitations in fixed-wing and rotary-wing aircraft.

(b) Dimensional factors, both horizontal and vertical, including consideration of the following:
   (1) United States rail system.
   (2) Foreign rail system.
   (3) Loading into covered rail equipment.
   (4) Military rolling stock.
   (5) Military motor transport.
   (6) Commercial motor transport.
   (7) Craft and amphibians.
   (8) Aircraft, both fixed- and rotary-wing.
   (9) Ocean shipping.
   (10) Operational use and experience.

(c) Relationship of cargo density to required internal cube.

(d) Relative importance of types of transportation media considered.

2. Résumé and evaluation of findings.
3. Consideration of optimum configuration.

The preceding plan proved to be satisfactory and resulted in the selection of container configurations which offer the promise of a high degree of over-all efficiency for the military transportation system.

Explanation of Methods Employed in the Analysis

In the time available it would be impossible to cover in detail all facets of the report. There is a large proportion of the material which would be of limited value in the commercial field since the study deals specifically with the military requirement. There are, however, certain aspects of the report which may well be of use in similar commercial studies.

The following portions of the report have been chosen for discussion:

(1) Weight factors, including lifting capacity of ship's gear and lifting capacity of quay cranes.
(2) Dimensional factors, including an analysis of the United States rail system and of ocean shipping.
(3) The relationship of cargo density to required internal cube.

Weight Factors—Lifting Capacity of Ship's Gear

An investigation of the methods of lifting containers by ship's gear revealed that a load of 10,000 pounds* poses considerable problems and calls for rerigging and/or the absorption of some portion of the safety factors. Military Sea Transport Service (MSTS) ships are equipped, in the main, with 5-ton booms and are therefore capable of lifting 6,000 to 7,000 pounds on burtoned gear without rerigging and in complete safety. Safety precautions must be observed in stevedore operations at any time, but their observation is particularly important in war when military stevedores, and indeed both ships' crews and reinforcements to the civil labour force, may be comparatively inexperienced.

Loads suitable for routine handling on 5-ton booms, rigged with normal burtoned gear, should not exceed 3 long tons; and any lift which does exceed this weight should be classified as "heavy lift" and handled by specially rigged gear or jumbo booms. If a situation is allowed to develop whereby a large proportion of containers falls within the category of heavy lifts, one of the main purposes of containerisation in speeding cargo handling will be rapidly defeated: the use of a jumbo boom slows down operations considerably; and, in addition, special rigs create a retardation in a critical area of cargo operations, as they are time consuming not only in the actual rigging but also in the "doubling" of gear (which doubles the hook cycle time).

* The present gross weight limit for military containers.

An analysis of derrick population, detailed in Lloyd's Register, was made and showed the following results:

Booms, 10-ton SWL	14.7 per cent.
Booms, 6- to 9-ton SWL	5.3 „
Booms, 5-ton SWL	46.5 „
Booms, 3- to 4-ton SWL	23.3 „
Booms, 1- to 2-ton SWL	10.2 „

This analysis indicated that, although the 5-ton derrick is the most commonly available equipment, a significant proportion of world shipping is equipped with booms with a safe working load (SWL) of 3 tons. Since it can be expected that in any future world conflict, shipping resources will be pooled, it would clearly be an advantage if containers in general use were of a weight that could be safely handled on either 3-ton or 5-ton booms.

Clearly a gross weight limitation of 4,500 pounds, which is the safe working load for 3-ton burtoned gear, is economically unacceptable when the capacity of normal 5-ton SWL gear is 6,000 to 7,000 pounds. However, if gross container weight is restricted to 6,720 pounds, a load is provided which can be handled on 5-ton burtoned gear and also on specially rigged 3-ton gear; therefore, this 6,720-pound load is considered to be a reasonable compromise.

Weight Factors—Lifting Capacity of Quay Cranes

Many foreign ports are equipped with portal or semiportal quay cranes, the majority of which have a capacity of 3 tons (6,720 pounds). In support of this statement, a census of cranes in eight representative major European ports revealed that, of the 1,578 available cranes, only 18 per cent. had a capacity in excess of 3 long tons. Since cargo operations can often be facilitated by the use of quay cranes, it would be advantageous to restrict the gross container weight to 6,720 pounds.

Dimensional Factors—United States Rail System

The objectives in this segment of the study were to ascertain the tray size which would provide optimum utilisation imposed

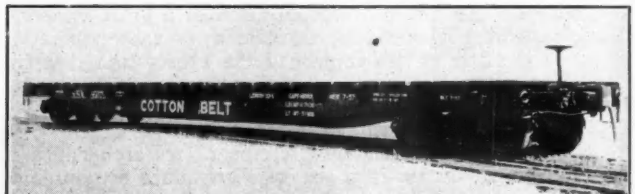


Fig. 2. Flatcars. Representative sample of 18,000 cars.

8-ft. 6-in. to 9-ft. 0-in. wide	14 per cent.
9-ft. 1-in. to 9-ft. 6-in. wide	11 per cent.
9-ft. 7-in. to 10-ft. 0-in. wide	8 per cent.
over 10-ft. 0-in. wide	67 per cent.

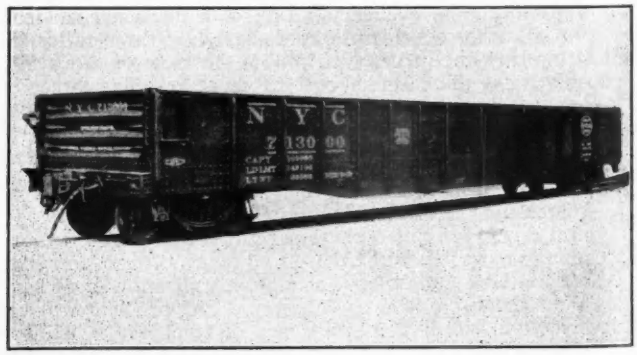


Fig. 3. Gondola Cars. Representative sample of 97,000 cars.

7-ft. 6-in. to 8-ft. 0-in. wide	5.5 per cent.
8-ft. 7-in. to 9-ft. 0-in. wide	3.0 per cent.
9-ft. 1-in. to 9-ft. 6-in. wide	81.5 per cent.
9-ft. 7-in. and over	10.0 per cent.

A Search for Optimum Container Size—*continued*

by fixed overhead obstructions which would influence the vertical dimension of containers.

For the examination of optimum utilisation of floor area, a compilation of the details of rail cars owned and operated by six of the largest American railroads was made and covered some 330,000 rail cars. An analysis of the internal widths of this rolling stock showed the breakdown by width classes. (See Figs. 2, 3 and 4.)

This breakdown showed that an 8-ft. dimension would fit transversely in all but 1.6 per cent. of the cars, that 65 per cent.

Fig. 4. Boxcars. Representative sample of 214,600 cars.

8-ft. 1-in. to 8-ft. 6-in. wide	20 per cent.
8-ft. 7-in. to 9-ft. 0-in. wide	17 per cent.
9-ft. 1-in. to 9-ft. 6-in. wide	63 per cent.

of the total cars reviewed had a width of 9-ft. 1-in. to 9-ft. 6-in., and that 70 per cent. of the flatcars and gondola cars had a width of 9-ft. 1-in. to 9-ft. 6-in.

It was then considered that, to ensure economic utilisation of floor space, one dimension should be set at 8-ft. (this size is adaptable to 98.4 per cent. of the cars); and, in view of the fact that the majority of cars have a width of between 9-ft. 1-in. and 9-ft. 6-in., the second dimension should be fixed at 9-ft. or a module thereof so that the container could be loaded on the cars either lengthwise or transversely. There were three possibilities for the second dimension, that is, 9-ft., 4-ft. 6-in., or 3-ft. It was decided that the 9-ft. dimension would be unacceptable, as a container with a horizontal dimension of 9-ft. by 8-ft. would be awkward to handle in the military system and would not be universally adaptable to cargo spaces. The 3-ft. width would also be unacceptable as this dimension would produce a container difficult to fill economically. It was concluded that a second dimension of 4-ft. 6-in. (giving horizontal dimensions of 8-ft. by 4-ft. 6-in.) was the most likely to provide the greatest efficiency in floor area utilisation on U.S. rail equipment.

To test this conclusion and to establish the advantages which would accrue from the use of these dimensions, a detailed study of the utilisation of floor area on flatcars and gondola cars was made; and the following tray sizes were selected for comparative analysis:

Proposed Dimensions ...	8-ft. 0-in. by 4-ft. 6-in.
Present Conex Size ...	8-ft. 6-in. by 6-ft. 3-in.
Alternative Dimensions ...	8-ft. 6-in. by 4-ft. 6-in.
Alternative Dimensions ...	8-ft. 0-in. by 5-ft. 6-in.
Alternative Dimensions ...	7-ft. 0-in. by 5-ft. 9-in.

Boxcars were not included in this segment of the study as it was felt that movement of containers in boxcars would inevitably prove uneconomical as compared to the use of open-top stock. However, it was recognised that, in an emergency, open-top stock will always be in great demand for the movement of tanks, vehicles, and other large equipment; and therefore, any container designed for wartime use must be adaptable for loading into boxcars. Movement of containers in boxcars was dealt with as a separate segment of the study.

The comparative analysis of types of rail cars covered 37 types of flatcars and 48 types of gondola cars. The method used was to calculate the number of containers of each size which could be loaded on the available cargo bed of each type of rail car, then to compare the area occupied by these containers to the available area on the car floor. From this comparison, an area utilisation efficiency figure was produced for each of the alternative tray sizes as related to each of the 85 types of rail cars. The following is an example of the data obtained.

(1) Available inside floor dimensions of rail cars: 37-ft. 4-in. by 9-ft. 4-in.

(2) Cars possessing these dimensions: 1,362 which is 7.4 per cent. of the sample.

(3) Number of containers which can be loaded, classified by tray size:

7-ft. 0-in. by 5-ft. 9-in. ...	6 containers
8-ft. 0-in. by 4-ft. 6-in. ...	9 containers
8-ft. 0-in. by 5-ft. 6-in. ...	6 containers
8-ft. 6-in. by 4-ft. 6-in. ...	8 containers
8-ft. 6-in. by 6-ft. 3-in. ...	5 containers

(4) Available area of car: 348 square feet.

(5) Area utilisation efficiency:

7-ft. 0-in. by 5-ft. 9-in. ...	69.4 per cent.
8-ft. 0-in. by 4-ft. 6-in. ...	93.1 „ „
8-ft. 0-in. by 5-ft. 6-in. ...	75.8 „ „
8-ft. 6-in. by 4-ft. 6-in. ...	87.9 „ „
8-ft. 6-in. by 6-ft. 3-in. ...	76.3 „ „

In this example, the 8-ft. by 4-ft. 6-in. tray clearly provides the best area utilisation. This situation was evident throughout the study.

After presenting a number of tables summarising the results of his analysis, Major Ablett concluded by recapitulating the desirable characteristics indicated by the sample factors considered.

1. Weight factors. The restriction imposed by ship's gear provides a compelling reason for the imposition of a gross weight limit of 6,720 pounds for normal operations.

2. Dimensional factors. The configuration likely to provide optimum utilisation of United States rail cars is as follows:

Length	8-ft. 0-in.
Width	4-ft. 6-in.
Height	5-ft. 1½-in. or less

However, the optimum vertical dimension for ocean shipping is approximately 6-ft. 10½-in.

3. Relationship of density of cargo to internal cube. The majority of military cargo suitable for containerisation has a density range of between 20 pounds per cubic foot and 50 pounds per cubic foot. To permit efficient loading within a gross weight restriction of 6,720 pounds, a 2-member family of containers with internal cubes of 200 cubic feet and 135 cubic feet is required.

Based on the foregoing, it can be accepted that the gross weight limit be fixed at 6,720 pounds, the container base dimension be fixed at 8-ft. by 4-ft. 6-in., the two vertical dimensions be fixed at 6-ft. 10½-in. and 5-ft. 1½-in. or less; and that the requirement is for a 2-member family providing internal cubes of 200 and 135 cubic feet.

Calculations are then made of the internal cube available in containers possessing such dimensions. The results show that the available internal cube conveniently matches the requirement, within a tolerance of 2½ per cent.

Although the author emphasised that his contribution was intended as an illustrative example and was therefore greatly simplified, in isolated instances the purpose of stating apparently self-evident facts is not clear. It is mentioned, for example, that a limitation is placed on the gross weight of the container by the materials handling equipment generally available at transfer points unless mechanical handling equipment of greater capacity is substituted. Although, too (as the author implies), the arguments used are not in every instance applicable to commercial work, the method of analysis employed is interesting and could be of assistance to commercial interests with a similar problem.

Liverpool Steam Ship Owners' Association Report

Wreck Removal, Demurrage and Quay Congestion

(By a Special Correspondent)

With the issue of the annual report of the Liverpool Steam Ship Owners' Association, following close on that of the Chamber of Shipping of the United Kingdom, the yearly stock-taking of the shipping industry may now be said to be complete. There are a number of matters dealt with in the Liverpool report which are of interest to dock and harbour authorities, particularly, of course, to the Mersey Docks and Harbour Board.

Reference is made to the Brussels Diplomatic Conference and the adoption of conventions in final form on limitation of liability and stowaways. The former was adopted nem. con., although there were several abstentions, including the United States. Among other things, this convention extends the right of limitation of liability to wreck removal claims by dock and harbour authorities, a right which in most United Kingdom ports does not exist.

This provision was made the subject of a reservation by a number of Governments at Brussels, including H.M. Government. Negotiations have been going on for some time with the Dock and Harbour Authorities' Association aimed at the withdrawal of that Association's opposition to the application of limitation of liability to such claims, but these had not been concluded prior to the Brussels conference.

Of more domestic concern is the question of demurrage. The view of the Association is that the shipowner should not be expected to pay for the detention of railway wagons which, under port arrangements, he does not control or, indeed, receive or handle. This particularly applies in the ports of which the British Transport Commission is itself the controller and wherein its own docks section has control over the reception and unloading of wagons, and in London where the Port of London Authority is in like position.

The report complains of too rigid administration without sufficient regard for local conditions. The Commission has insisted on dealing with it centrally. This fact has lain at the root of all the trouble. In the port of Liverpool, which is the Association's principal concern in the matter, the Association believes that a change of outlook over centralisation would speedily be productive of agreed and acceptable terms for Liverpool. Further, it is in the different ports that can best be tested and met the main contention of the committee of the General Council of British Shipping that wagon demurrage in the ports should be a penalty for default falling where the default lies and not on one who is innocent of default.

As between, for example, London, Liverpool, Newport and Glasgow, conditions in relation to the reception and discharge of wagons vary considerably and the extent of application of the argument varies with them. Hence the need for local examination of the circumstances by the two sides and for arrangements which in each of the ports concerned will take fairly into account the conditions ruling in each of them. On these lines, says the report, it is certainly not an insoluble problem. The experience of the last ten years has shown that it will remain a continuing trouble so long as these considerations continue to be ignored.

Courses for the training of Merchant Navy officers in fire protection and fire fighting, which were begun at the instance of the Association in 1954, were continued during the year. Since the start, over 2,270 officers have been through the course, coming not only from members of the Association and from the Mersey Docks and Harbour Board but, by special request, from as far afield as Dublin and Rotterdam.

The arrangements made between the Association and the Chief Constable of Birkenhead for special watching of ships at the Birkenhead docks have been continued. The cost of these special arrangements is borne on an agreed basis of apportionment by the members of the Association concerned, who retain satisfied that their value in protecting cargo from pilferage justifies their continuance.

Discussions have continued with the Ministry of Transport on the question of extension of the indemnities applicable to H.M. Government explosives to explosives moving at the instance of Visiting Forces Authorities. The matter concerns both the shipowners as carriers and those, such as stevedores and master porters, who handle explosives in the ports of this country. The fact that the negotiations have taken so long to bring to finality is largely due to the number of governmental authorities concerned, but it is hoped soon to bring them to a satisfactory end.

The Association continues to co-operate with other organisations in providing the Ministry with statistics of the turn-round of ships in United Kingdom ports. In Liverpool, the port authority undertakes the task of compilation of aggregate returns from information supplied by selected members of the Association. These aggregate returns go, with those from other ports, to a joint committee of the participating organisations by which they are examined and sent to the Ministry. The Association adds that it is an open question whether the exercise is deserving of the considerable amount of work it involves.

Commenting on the fact that 1958 is the centenary of the Mersey Docks and Harbour Board as well as that of the Association, the report comments that the foundation of the Association was linked to some extent with the constitution of the Board in 1858 under Act of Parliament. From that time onwards the two bodies have worked closely together for the well-being of the port of Liverpool and many of those who have taken the lead in the affairs of the Association during all these years have also been members of the Board and, as such, responsible for the conducts of its affairs. The Association takes advantage of the opportunity to tender to the Board its congratulations on its centenary and its good wishes for the future.

The port dues and charges on ships and goods were increased at Liverpool during the year by approximately 11 per cent. The circumstances were such as to compel the Board to impose the increase and the Association concur in it. The town dues remained in abeyance pending the outcome of a case in the Law Courts to decide a legal question of the concern of the Minister of Transport with changes in their level, a case in which the decision went in the Minister's favour. Parliamentary action in the result is necessary and the Board is taking it.

The special committee appointed by the Association in 1955 has continued its endeavours to secure speedier clearance of import cargoes from the quays and thereby relieve congestion and facilitate the quicker turn-round of ships using the port of Liverpool. As stated in earlier reports, the committee has found that the overriding factor causing delays in the port was failure on the part of receivers to clear their goods in good time and the miuse of quay space as temporary warehousing accommodation and for purposes of marketing, sampling and similar operations.

The remedy for these malpractices lies, the report says, in stringent imposition of penalty rents and the removal of offending goods into warehouse at the expense of their owners, and the Association continues to look to the Board to exercise their powers in this direction whenever occasion demands.

The investigation carried out by the special committee in 1955 revealed, over the short period of four months covered by it, that in the case of 165 ships examined, time equivalent to 600 days was expended in discharging operations over and above that which, given normal dispatch, would have been occupied. The position undoubtedly has improved since then. In order that it may be kept under constant review, the Association is collecting periodic figures of delays incurred by ships either awaiting berth or in berth by reason of congestion of the berth and also figures of the time taken to remove cargo from berths.

The Association has taken part in talks with British Railways, convened by the Board at the request of the chairman of the British Transport Commission, with a view to increasing efficiency in the handling of rail traffic in the port.

The Association's Master Porters' Rates Committee has taken part in the work done by the Association for the improvement of quay congestion and in the turn-round of ships. It has also dealt with a number of porterage matters, including the application of rates on various commodities, new arrangements in connection with watching, and questions relating to counting off books.

Modern Dry Docks: Design, Construction and Equipment

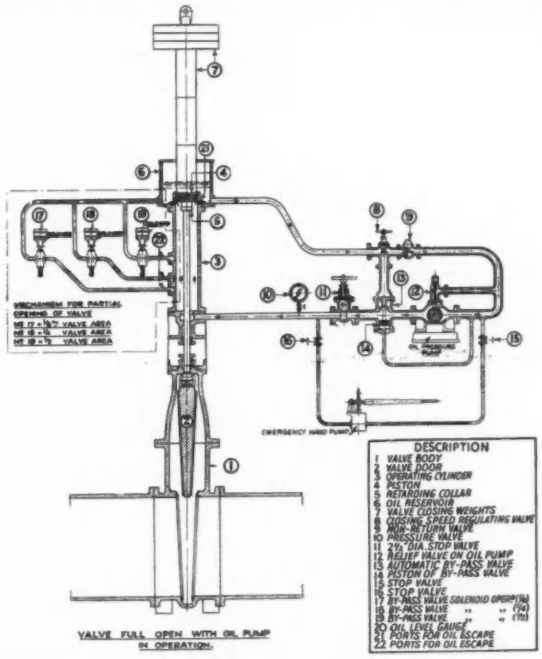
VI Dock Pumping Machinery

By G. A. WAUCHOPE, M.I.Mech.E., A.M.I.E.E., M.I.W.E., Mem.A.S.M.E.

(*Continued from page 389*)

Main Pump Valves

Various forms of main pump valves may be used, these are distinct from the penstocks which are usually situated outside the pump house. Their purpose is, amongst other things, to enable the pump to be isolated so that it can be dismantled without interfering with the functioning of other pumps in the station. Suction sluice valves can be omitted but this means that the pump can only be dismantled or the interior examined when the dry dock is completely de-watered and in most recent large docks, they have been installed. Discharge sluice valves not only are used for isolation purposes, but can also be used for controlling the rate of de-watering, particularly where centrifugal pumps or certain special designs of mixed-flow pumps are employed. When it is necessary to start a pump with the water level in the dock so low that it has to be primed, the discharge sluice valve can be closed.


DESCRIPTION
1 VALVE BODY
2 VALVE DOOR
3 OPERATING CYLINDER
4 PISTON
5 RETARDING COLLAR
6 OIL RESERVOIR
7 VALVE CLOSING WEIGHTS
8 CLOSING SPEED REGULATING VALVE
9 NON-RETURN VALVE
10 PRESSURE VALVE
11 2½" DIA. STOP VALVE
12 RELIEF VALVE ON OIL PUMP
13 AUTOMATIC BY-PASS VALVE
14 PISTON OF BY-PASS VALVE
15 STOP VALVE
16 STOP VALVE
17 BY-PASS VALVE SOLENOID OPERATED
18 BY-PASS VALVE " "
19 BY-PASS VALVE " "
20 OIL LEVEL GAUGE
21 PORTS FOR OIL ESCAPE
22 PORTS FOR OIL ESCAPE
VALVE FULL OPEN WITH OIL PUMP IN OPERATION.

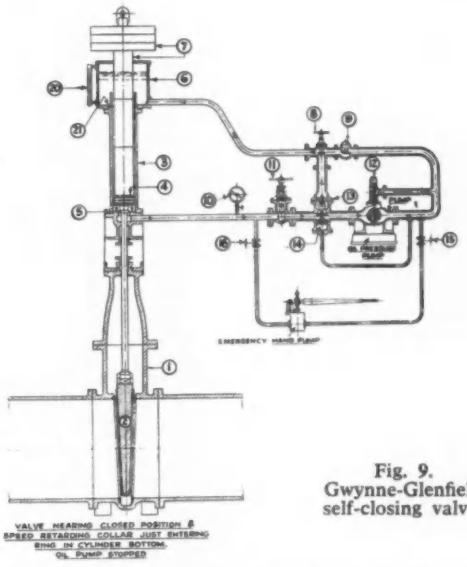


Fig. 9. Gwynne-Glenfield self-closing valve.

A special problem is involved in the accidental stopping of dry dock pumps which may be occasioned by the failure of electric supply or other inadvertent switching-off of the motor, especially when the dock is nearly empty. Under these conditions the velocity of the water in the discharge piping drops very quickly indeed and in, literally, a fraction of a second, may have obtained a high velocity in the reverse direction. This is because the kinetic energy of the rotating parts of the pump and motor is very rapidly absorbed by the pump impeller, causing quick deceleration of the pump.

In most cases the pump discharge pipe is very short and consequently the kinetic energy of the water moving in the pipe is small and is rapidly absorbed. It will be appreciated that it is extremely difficult to design a flap type of reflux valve which can respond so quickly to the reversal of flow as to prevent heavy slamming of the flaps on their seatings which, apart from the heavy mechanical shock which may result, can set up high hydraulic pressure surges which may cause appreciable damage. So as to avoid this risk many of the largest dry docks have been provided with some form of self-closing discharge sluice valve and flap type reflux valves have been omitted. The general principle upon which these valves function is that, although they are opened directly or indirectly by electric or hydraulic power, they are always closed by gravity and consequently are entirely independent of an external source of energy. The rate of closing is adjusted so that even if rapid reverse flow of the water takes place, the deceleration of this is so gentle that no dangerous pressure surges are set up and, although the pump may be caused to rotate in the reverse direction for a short period, no shock, either mechanical or hydraulic, can take place.

Various forms of these valves have been installed, most of them are opened by a hydraulic piston, the pressure fluid for which may be supplied from the dock hydraulic system, from a specially installed hydraulic accumulator and pressure pump, which will usually be employed to operate all the large valves in the station, or by separate electric pumps, one for each valve. The latter arrangement is the most usual and Fig. 9 shows a diagram illustrating the principle of this design. In every case interlocking arrangements are made so that, immediately the main pump stator switch opens, the hydraulic pressure which maintains the valve in the "open" position is released and the valve is closed by gravity. An incidental advantage of this type of valve is the saving of space which would otherwise be occupied by a reflux valve.

In cases where the pump discharge pipe is of some considerable length and, in consequence, multi-flap or similar types of reflux valves can be used, the discharge valve may be electrically operated and if the time for opening or closing the suction valve is long because of its size, this may also be electrically driven.

Modern Dry Docks—continued

The Use of Syphons in the Main Pump Discharge Pipes

In some dry dock pumping stations it is possible to arrange the run of the pump discharge pipes so that each of them form a separate syphon. A typical arrangement is shown diagrammatically in Fig. 10. It will be seen that the invert of the top bend of the syphon is situated so as to be well above the high water level into which the pumps discharge. Air valves are mounted on top of the syphon bends and these are designed so as to be closed when the pumps are operating but open when the pumps stop and consequently break the syphon and prevent return flow of the water in the docks.

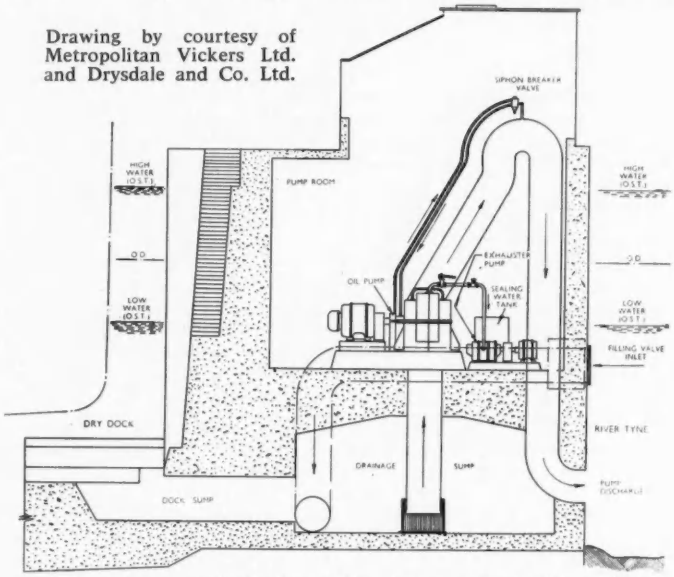


Fig. 10. Diagrammatic Section of Pumphouse with centrifugal dock pump and syphon discharge pipes instead of valves.

When the dock is full the pumps can be started up and after a short time the velocity of the water passing through the syphons will be sufficient to entrain the air which has been trapped at the top and the pumps will function normally. If the water level in the dock is below the pump casing when they have to be started up, they have to be primed by an air exhauster as described below.

By this means the necessity for pump valves is eliminated although in some cases it may be desirable to employ a suction sluice valve for isolating purposes. It may be found necessary to design the pumps for a higher head than would otherwise be the case so as to ensure that there is sufficient velocity of water to prime the syphons when the dock is nearly empty and in consequence the average efficiency of the pumping operation may not be as high as would otherwise be the case. Furthermore, owing to the absence of the discharge valve, it is not possible to reduce the pump discharge by throttling.

Priming Systems

When the water level in the dry dock is below the level of the pumps they will not start up unless the air is exhausted from the casings and they are filled with water. The priming or exhauster pumps may be of several different designs. They are usually electrically driven and designed to prime one of the main pumps in, say, five minutes under the worst conditions—viz. when the water in the dock is practically at grating level. The exhausters may be of the multi-cylinder reciprocating type, the rotary vane type, the water-ring type or, in some cases, water-ejectors have been used. Excepting in the last two cases it is very important that water should not be drawn into the exhauster and therefore some form of interceptor is usually provided, probably comprising a cylindrical vessel containing a float which operates an air valve that will shut-off the exhauster from the pump when the vessel fills with water and the float rises.

In most cases the drainer pumps are situated at such a level that they have to be primed every time they start up. Consequently a fairly complicated system of exhauster piping has to be installed with the appropriate isolating valves.

Centralised Control

It has been explained that where there are a number of main valves, main penstocks and probably two or three main pumps, it is modern practice to employ a form of centralised control.

This usually comprises a central control desk on which are mounted switches which start and stop the pumps or open and close the valves and penstocks. A separate mimic diagram may be provided which shows which pumps are working and which valves or penstocks are open. In more recent designs "telephone" type of equipment has been used in which the diagram and the switches and indicators are combined on one desk. When possible, the indication is independent of the operating circuit. For example, the switches which operate the "closed" or "open" indicating circuits of a sluice valve are mounted on the valve itself and are worked mechanically by the valve motion. In some designs the indicating lamps are arranged to flicker when the valve is partially open.

Indication of the water level in the dock, in the drainer sump and in the sea or river outside the dock, is usually provided on the control desk and may be one of the usual electrical types of instrument. Where the operation of the penstocks is complicated by the dock having two or more sections or the pumping station used with two or more dry docks, the practice is to employ master selector switches on the control desk by means of which the required combination of valves is set. When the operator pushes a button, all the valves come to the "closed" position and the appropriate ones are then automatically opened, indication of the functioning being visible on the mimic diagram. By this means the risk of damage by accidental flooding through incorrect operation of the valves or penstocks is minimised.

It is usually arranged that each pump and each valve and penstock can be controlled by push-buttons mounted near to the item of machinery to be operated so that, in the event of failure of the control desk system, operations can be carried on. To achieve this, each item is provided with a separate selector switch with the positions "remote control," "off" and "local control."

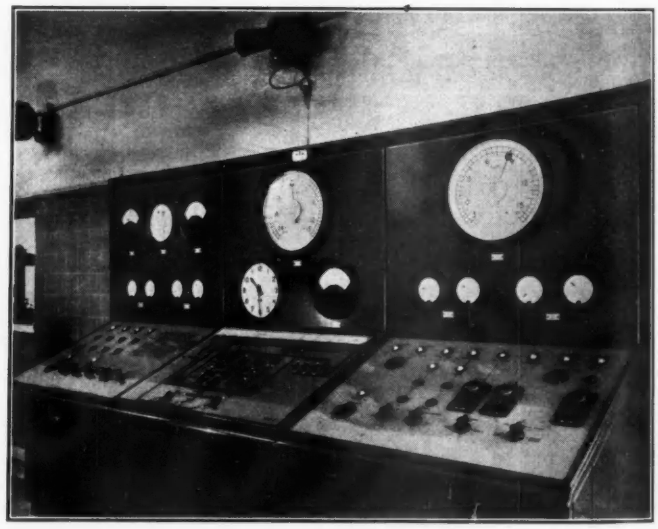


Fig. 11. Main Control Desk at Dublin with Level Indicators, Mimic diagram, Pump gauges etc.

Operating instructions may be received at the control desk from the official responsible for the docking either by loud-speaking telephone or by marine-type engine-room signal.

Fig. 11 shows the main control desk at Dublin.

In some pumping stations a separate float-operated mechanical level indicator, showing the amount of water in the dry dock, is installed in addition to the electrical indicators so that in the event of a failure of the electric supply to the instruments, the operator is still made aware of the water level.

Modern Dry Docks—continued

AUXILIARY PUMPS

Drainer Pumps

So as to avoid the necessity of operating the high-powered main pumps to deal with the accumulation of water which may have leaked into the dock, rain water or from other sources, drainer pumps are usually supplied.

The capacity of these is dependent upon the circumstances but as they have to operate very nearly continuously over long periods of time, it is usual to have two sets, one being a standby to the other. In the larger docks they may have a capacity as great as five or even ten thousands gallons a minute especially if the dock facilities include providing cooling water for auxiliary condensers on board ship in which the discharge is returned to the bottom of the dock.

These pumps are usually constructed of the same material as the main pumps, they are frequently of the vertical spindle type and are usually centrifugal pumps. They can be automatically started and stopped by the level of water in the drainage culvert but are more usually hand-operated. In some underground pumping stations, special precautions are taken involving automatically operated electric sluice valves arranged so that should there be an accidental flooding of the pump room itself, the drainer pump suction will be connected to a sump in the pump room and it will be started up automatically. When this is done it is usual to instal the drainer pumps at a lower level than the main pumps so that they are automatically primed if the pumping station is flooded.

Normally the drainer pumps have to be primed by the exhauster system but in some of the smaller docks marine-type self-priming pumps are used as drainers.

Where more than one dock is served by the pumping station or where it is desired to be able to isolate the main pump suction sump, a separate drainer sump is employed.

Seepage Pumps

Small electric automatically operated pumps are used for discharging seepage water from main pumps glands and other causes. They are usually of the centrifugal type and the motors may be mounted at a high level so as to make it possible for the pumps to be run should there be an accidental flooding of water into the pump room.

General Service Pumps

These pumps are usually employed for drawing water from the sea or river, they work at relatively low pressures and provide water for the ship for washing-down or, in the case of naval vessels, for magazine flooding, etc. In some cases facilities are arranged so that these pumps can supply condenser water for the auxiliaries on the ships in dock. The pumps are usually of the centrifugal type and may be situated at any convenient position in the pumping station, bearing in mind that they draw water from the outside of the dock.

Fire Pumps

It is usual to instal one or more fire pumps in the station. These are connected to a hydrant system going round the dock wall and various methods are used for setting them to work.

It is usually desired that the fire main shall be kept under pressure and for special safety reasons it is sometimes arranged that one of the fire pumps is run continuously while a ship is in the dock. It is provided with a small by-pass to prevent overheating. Alternatively, instead of running one of the main fire pumps, a small auxiliary pump is kept in operation. It is provided with a pressure switch so that as soon as a reasonable quantity of water is drawn off the fire main, the pressure temporarily drops, the pressure switch starts the main fire pump which brings the pressure back to normal and, of course, discharges an adequate supply of water for fire-fighting. Depending upon the pressure required, the pumps may be of the single- or multi-stage centrifugal type and are frequently of the vertical spindle arrangement.

Handling for Export

Review of Port Operating Methods

As reported in last month's issue of this journal, a conference on Recent Developments in Materials Handling was held in London in February last. It was organised jointly by the Institute of Materials Handling and the Polytechnic, Regent Street, and the introductory talk by Sir Leslie Ford, General Manager of the Port of London Authority, was also reported last month. A maritime flavour was given to the proceedings by a paper on "Handling for Export," which was presented by Mr. E. S. Tooth, who discussed the close relationship between handling methods in the ports and those being adopted in other industries as a result of their employment of new and revolutionary handling machines. It can be said, indeed, that in many cases these methods are complementary. The following are extracts from Mr. Tooth's paper.

British Exports

The manner in which goods are handled for export is not determined by dock facilities and methods only. As I hope to be able to show, there are many other factors involved.

As you are aware, in many ports, exports are tendered to ship loading berths by road, rail and water conveyance. Speaking generally, of those transported to the berth by land vehicle, the majority are first shedded but a proportion is shipped direct. At some ports, there are more facilities for road traffic; at others, for rail. In a few ports in the United Kingdom much of the traffic is water-borne. In London, over half of the total tonnage of exports is tendered to ships by barges. Of the remainder, the bulk arrives by road vehicle.

The volume of British export traffic is now immense. Through London, for example, the figure has risen from about 4½ million tons deadweight in 1948 to over 9½ million tons in 1957. For the country as a whole, the value of exports has risen during the same period from 1,600 million pounds sterling to £3,326 million pounds. However, it is not only the **quantity** which makes handling through the ports a complex operation, it is also the **character** of our exports. They range from asbestos cement sheets to 80-ton boilers, from stockings, paints, razor blades, spirits, dyes, cereals, textiles, cosmetics and chemicals to girders, anchors, steel tubes, drums of cable, earthenware pipes, linoleum, machinery, racehorses, railway engines and, of course, motor cars.

Port Organisation

At a busy port there is need for a tight organisation if the tendering each day of vast quantities of such miscellaneous goods by thousands of lorries and railway trucks is not going to cause chaos. Although efforts are made to keep the same type of traffic to the same berth, this is by no means always possible. On the other hand, certain traffics **demand** special facilities. For example, a vessel taking a large quantity of motor cars on wheels must have a berth where there is plenty of open ground suitable for parking—otherwise there will be expensive delays. With such traffic, prior advice of the time of arrival and of the quantity of cars involved will normally be given to the berth—a step which is also necessary when other special cargoes — heavy lifts, for example—are to be tendered.

Unless special arrangements **are** made, heavy lift traffic can easily dislocate the work in the transit shed and also cause important delays to vehicles tendering other consignments as well as to the actual loading of the ship. They often have to be specially routed to the docks and, as I have said, it is usually important, too, to time their arrival, for they will have to be handled by special means.

There is no regular pattern in the work of handling heavy lifts for export—nor, indeed, is there in much other dock work. Your heavy lift arriving at the dock on a low loader or special railway wagon may, therefore, be lifted direct from vehicle to ship (if she is equipped with a sufficiently heavy derrick and has suitable stowage available) or placed on a heavy-duty truck so that it can be moved alongside the ship when required. If neither of these

Handling for Export—continued

methods is convenient or possible, it may be off-loaded at another part of the dock by, say, a heavy-duty quay crane (which may be at a dry dock) to be later barged to the ship. If the vessel has not got gear of sufficient capacity, then a floating crane will probably come into the picture. This may carry the lift to the ship or only have to hoist it from barge into hold.

The point which is being emphasised is that if exports, whether special traffic, such as cars and heavy lifts, or general goods, are to be handled in the docks efficiently, there must be a keen organisation responsible for receiving them and for loading them into the vessel—and the handling authorities at the docks are usually only **one part** of the organisation.

Especially at ports where berths are at a premium, arrangements will often be made with the shipping company for exports for their vessel to be sent to the berth only between certain stipulated dates. Often, when the ship is calling at more than one port, these receiving dates are staggered so that goods for the early ports of call are received and ready for shipment first. This reduces shed congestion and speeds vehicle turnround. However, not only must the berth be kept fluid and adequate facilities always be available on the quay, it is often also necessary to pre-

[Photo P.L.A.]
Cars for export awaiting shipment at one of the London docks.

pare the ship and her gear before loading starts, to ensure that gangs, vehicles, barges and cranes do not waste valuable hours. An extreme example of this has been happening recently with certain vessels taking an almost full freight of motor cars on wheels. These cars have been loaded into conventional general cargo vessels but before the loading operation commenced, ship repair firms have put in additional temporary wooden decks, making, with the permanent decks, accommodation for, perhaps, 5 or 6 tiers of cars in all. In some cases this has trebled the vessel's carrying capacity for motor cars on wheels.

As I have already stated, at a busy port there is need for a tight organisation if the work of handling exports is to proceed speedily and economically, for the conditions of dock work vary from port to port, from berth to berth, from ship to ship, from cargo to cargo and from hour to hour. There are no standard conditions as in a factory. Handling for export is, therefore, not without its problems, most of which arise with general cargoes shipped across the quay.

Manual Handling

Prior to the late war, manual handling of exports was common practice. Goods were tendered in bags, bales, drums, cartons, cases and so on and usually different equipment had to be used for each kind of package. There are still many export berths which are manually operated. There are various manning arrangements but, at a berth typical of those at many ports, consignments of exports are unloaded by port labour from lorry or railway wagon on to hand trucks, which are then pushed into the transit shed to the appropriate port stowage. Here the cargo is piled manually up to about shoulder height to await shipment, and it is a fact that, however long the shed may be, it is usually possible to stand at one end of it and see the wall at the other. When the cargo is required by the ship, it is unpiled on to hand trucks and pushed to the quay alongside the appropriate hold. Here it is transferred package by package to the stevedores' slings, lifted aboard and stowed in the hold manually. It is worth noting that by this manual arrangement, each package is man-handled five times, viz. from vehicle to hand truck, from hand truck to shed stowage, from shed stowage to hand truck, from hand truck to stevedores' slings and from stevedores' slings to stowage in ship. The implications of this in terms of time and costs (including packing costs) are obvious—especially when it is appreciated that we are looking at only **one** point of change of custody of the goods.

Handling Revolution in Industry

Soon after the termination of the late war, a revolution began in materials handling methods. This was due to the introduction into factories and workshops of certain new machines and particularly of fork lift trucks. To understand the problems now attending the handling of exports through the docks, it is necessary to examine what has been happening in industry in the hinterland for the last ten years.

The fork lift truck was first used with pallets in comprehensive schemes by some of the bigger manufacturing organisations to move their products within their own premises. The method proved so successful that, in a very short time, palletised goods were being transported by the firm's own cartage organisations to their distributing depots throughout the country. As firm after firm adopted similar handling methods, this traffic was soon being offered to the common carriers, who immediately found difficulty because of the big variety of pallet sizes they were called upon to transport. Some sizes were slow and awkward to handle, many gave no opportunity for economic loads. Thus there was soon a demand for pallet standardisation.

This task naturally fell to the B.S.I. who, in due course, issued their standard—B.S. 2629 "Pallets for the unit load method of materials handling"—and the main factor which influenced the British Standards Technical Committee in recommending certain pallet sizes was the dimensions of British road and rail vehicles.

Mechanisation of Port Operating Work

The handling of imports by machines was found to be extremely difficult because of the almost constant need for sorting, even homogeneous parcels, to marks, numbers, counts, sizes and so on. Thus, although export cargoes were of such a miscellaneous character, since no sorting operation was involved, they presented a better opportunity for experiments.

The idea, of course, was to handle exports a load at a time rather than package by package—in other words, if the throughout movement method was not operating across the seas, or at least across the oceans, a segment of it could be usefully worked in dockland. To achieve this, certain ports introduced fork lift trucks and dock tool pallets in different ways.

Mechanised Export Berth

The Port of London Authority aimed at mechanising the handling of exports primarily because they believed that ships could be turned round quicker by these means. Their scheme was to palletise consignments at the time of receipt and keep them on pallets until they were in the ship's hold—that is, to have two manual handlings instead of five. Their plans succeeded and the system at their mechanised berths is now as follows: The consignments of exports are lifted from vehicle (usually by mobile crane) direct on to dual-purpose dock-tool pallets. The pallet first used was all wooden, it measured 4-ft. x 6-ft. and for crane-lifting purposes, had 5-in. wings. The wings, however, did not stand up to robust dock-handling and a new type of pallet, having metal eyes, was designed in the dock and ultimately replaced the winged pallet. This dock-tool pallet measures 4-ft. 6-in. x 6-ft.,

Handling for Export—continued

its decks are strong wooden slats, its centre bearer wooden and its end bearers mild steel channel. The eyes are welded to the ends of the metal bearers and the result is a pallet-landing board, a piece of equipment which can be conveyed on the ground by fork lift truck and lifted aboard ship by crane or winch. This tool has now been permanently incorporated into the work and goods tendered by either road or rail vehicle are loaded direct on to the pallets. The loaded pallets are then picked up by fork truck, which conveys them into the shed and piles them 2, 3 or 4 loads high in the required port stowage. The subsequent unpiling and conveying to ship's side is also done by fork lift truck, which deposits the loaded pallet on the quay. All the men at the ship's side have to do is to engage four hooks in the pallet eyes. The pallet is then lifted aboard for unloading, being later returned empty to the quay.

Special arrangements made with both H.M. Customs and the shipping companies' Cargo Superintendents permit the necessary examination and tallying of the goods loaded on to the pallets. The result is that when it is necessary to tender the goods to the ship, there are no delays of any description and one machine can easily keep a ship's gang fully employed. In the early days of this work it was often necessary to restrain the enterprise of the fork lift truck drivers. I remember, for example, standing on the quay watching the operation of loading the ship. At one hold, there were apparently two loaded pallets on the quay, one behind the other. As the front one was lifted aboard, the second one moved itself forward to the ship's side and a third followed it along. Investigation showed that the energetic fork lift truck driver had got eight loaded pallets waiting in single file and as the front pallet was taken aboard, he pushed the whole rank forward. This kind of thing had to be stopped immediately, of course, but it does show how well a ship can be served at a mechanised berth —compared with the feeding of a ship's gang by manhandling cargo package by package from hand truck to stevedores' slings. The psychological effect of this speedy quay service has been seen in the tonnages handled, since in most instances ships' gangs as well as quay gangs work on piecework conditions.

The number of men required for the two operations, receiving from the vehicle and piling in shed and later tendering to the ship, is nine, compared with sixteen at the manual shed. In London, exports for Australia, the West Indies, South Africa, the Mediterranean, India and Pakistan are being handled at mechanised berths in the manner described and in all cases it has been found possible to palletise at the time of receipt over 98% of the cargo tendered (excluding, of course, vehicles on wheels). At some of these berths, mechanisation has resulted in an increase in the speed of loading the ship of over 20% deadweight tonnage. The number of times individual packages are manhandled is reduced to two, i.e. on the pallets and off the pallets. Thus, besides the increase in speed, there is a saving of arduous labour and there is also a reduction in damage risk. Another important benefit is that by the new method much more of the cubic capacity of the shed is used. No longer is it possible, as at the manual berth, to see one end of the shed from the other, for piling is up to sixteen or eighteen feet high and at some berths shed capacity is more than doubled.

Concurrent Developments in Industry

Whilst such methods as these were being perfected in the docks, other industries had not stood still. In the transport world, changes had been made in road and rail vehicles, so that palletised traffic could be handled with greater speed and safety. British Railways, in fact, had begun to build a fleet of special pallet wagons and now carry some 300,000 tons of palletised freight annually.

Alterations were made for the same reason in transport vehicles on the continent of Europe and here and there some interesting new schemes were launched. The Swiss Federal Railways, for example, purchased some 200,000 32-in. x 48-in. pallets and with more than 600 industrial organisations, introduced a pallet exchange scheme, which now operates in the following manner. When a member delivers, say, 50 pallet loads to the railway depot, he receives 50 similar pallets in exchange. When the loads ultimately leave the custody of the Swiss Railways, the receiver, also a member of the scheme, also gives 50 pallets in exchange. The obvious advantages of the scheme include the part-solving of the "returned empty" problem. Other continental nations have since followed the Swiss lead in this matter and at the present moment the International Chamber of Commerce is dealing with the possibility of instituting an international pallets pool.

Layout of Premises

The pattern of industrial premises altered, too. Many factories and workshops were adapted or newly built to suit fork truck handling and many new warehouses and depots were constructed with divisions or sections of dimensions which were multiples of the sizes of the unit loads they were expected to accommodate.

Fork Lift Truck Traffic

These developments are not remote from port work. Sooner or later they have their effect on it. Already standardisation, changes in packaging, new materials handling methods, alterations to transport vehicles, specially designed premises, are having their effect upon export traffic. Slowly but surely an increasing percentage of goods are being tendered to the docks packed in such a way as to be suitable for handling mechanically and especially by fork lift trucks. Such traffic now includes:

(a) consignments (i) on substantial reversible pallets, (ii) on light single-deck pallets, (iii) on expendable pallets
(b) unit loads built with apertures for the fork prongs
(c) packages on stillages or having special bearers or battens thick enough to allow the fork truck to pick them up
(d) containers on pallets or on thick bearers.

[Photo P.L.A.]

Temporary wooden decks installed in a ship's hold to take additional tiers of motor cars on wheels.

In some parts of the world, there have even been consignments shipped on expendable pallets which are made of the export material itself.

As I have said, many goods are packed in one or other of these ways because fork truck handling is required at manufacturers' or shippers' premises; others are so packed to ensure that they will not be damaged by mechanical handling at any stage of their journey. For whatever reason they are packed in this way, however, they are becoming known to us in dockland as "fork lift truck traffic."

Effects on Port Industry

In the ports, therefore, a second factor is making for increased mechanisation in the handling of exports. There was first the enterprise of port officials who used fork trucks and dock tool

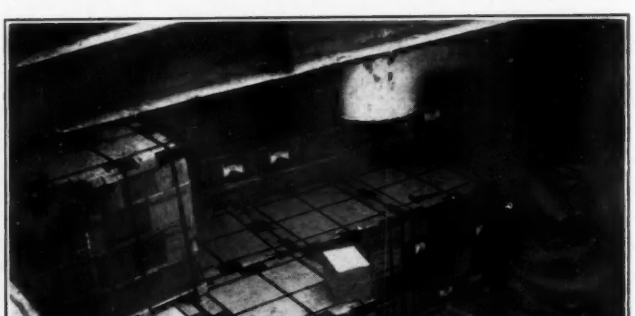
Handling for Export—continued

pallets instead of awaiting the arrival of unit load traffic; now there is an increasing proportion of exports packed so that they **can** be (in some cases, **must** be) handled mechanically.

These new methods of packing and also of transporting and handling have had their effect also on port premises. Existing premises have had to be adapted and special attention paid to the design of new premises. In London, new sheds have been built with good approaches for road and rail traffic, wide quays (equipped with 3-ton and 5-ton electric luffing cranes) and big doorways to allow easy access for handling machines. The sheds themselves have level, hardwearing floors, few columns and good natural and artificial lighting—for piling by fork lift truck is often a meticulous operation. In new multi-storied sheds, ground floor height is as much as 24-ft. 6-in.; upper floors are 16-ft. 6-in. high. Loading limits permit 3-ton fork lift trucks to operate and to pile on all floors. I ought to mention that a further benefit which accrues from the mechanisation and modernisation which I have been describing, is quicker vehicle turnround.

Effect on Ship Design

I have tried to show how handling for export is affected by many factors inside and outside the port and how unexpectedly close the connection between these factors frequently is. It



[Photo P.L.A.]

Unit loads of canned goods (from South Africa) for fork-lift truck handling, showed in the hold with loose cargo (other canned goods and bales of wool).

could not be expected that since most links in the through-transit chain have been effected, the ship could remain an exception. For one thing, exports which **must** be handled by machine on the quay, often require mechanical handling in the ship.

Nowadays, most crane-equipped export berths have a proportion of 5-ton cranes. At some berths—where there is a considerable proportion of heavy container traffic, for instance—crane capacities are even higher. As is to be expected, therefore, many new ships are equipped with derricks or deck cranes of at least 5-tons capacity. Another tendency is the provision of flush 'tween decks and hatch covers strong enough to bear the weight of a loaded 3-ton fork lift truck. In ships so constructed, care has been taken to ensure that there are no cleats, trimming hatches, stanchions or any other obstructions to the operation of mechanical appliances and usually hold ceilings are horizontal and level. Attention is also being paid to deck heights, so that fork lift trucks can easily utilise all the cubic capacity of each hold. Ships built on these lines are already in commission. Some of them actually carry their own complement of battery-driven pallet trucks, with charging facilities also aboard.

Conclusion

In this matter of handling for export, therefore, although port operating organisations have a duty at least to change with the times, the problem is not only a dock one. Wise shippers will instruct their packers to find out what sort of facilities there are or there **can** be, at the ports through which their consignments are going.

Export packers maintain that export packing is a science. Modern methods certainly take into account many important requirements, particularly those connected with the condition of contents — but the main problem now is to meet the difficulties arising from the gradual change from manual to mechanical handling. What does an export packer do, for example, when he knows there are mechanical handling methods at one end of the sea journey and manual methods at the other? and, I might add, what does the port operator do when he receives simultaneously at the same berth some consignments specially packed for mechanical handling and other cargo loose? For loose goods he will want three times the number of men required for handling the unit loads and he cannot increase and decrease the size of his gangs every half hour or so. Another question which is asked is whether handling methods should be adapted to the kind of package, or packaging to the kind of handling methods.

The answers to all these questions lie, of course, in the field of co-operation. As I have stated, most of them arise because, not only in the transport industry, we are in an important transition stage of materials handling. This creates difficulties with premises, equipment, transport (including shipping) and, of course, labour. There is no doubt whatever that much more port operating work could be usefully mechanised, if the rank and file of dock labourers would implement the promises of their leaders. In some instances—with regular liner traffic, for example—there is a pattern into which new handling means could be more readily fitted.

In any case, however, it may be that the kind of mechanisation at present being developed in the docks is by no means permanent. Everywhere there is a tendency to transport goods in load form rather than loose. The growing bulk traffic, the container traffic, the ferry traffic and what has come to be known as roll-on, roll-off traffic, as well as the increase in unit load traffic, are evidence of this. In designing port premises such as the London sheds just described, port authorities have tried to meet what are in the main unknown requirements well into the future.

During peak-trade times money can be afforded for experiments. Many new practices and, indeed, many old ones survive only because there is money about. Often these are more crucially tested when money is tight and, if competition for traffic becomes more keen in the future, we shall see keener attention paid to handling methods and costs. In that case, it is believed that the tendency to transport goods in bulk or in some kind of load form will increase quicker. For one thing, the occupation by pallets of freight space ceases to be a problem when ships are not being filled.

In such circumstances, handling operations through the docks may well become less complex. Even if that happened, I can assure you that we shall still require men of enterprise to supervise them.

Oil Handling Facilities at Finnart, Scotland

It has recently been announced in Scotland that the new ocean terminal for handling oil tankers, which is in course of construction at Finnart, Loch Long, for the B.P. Group, will be in full operation by the end of this year. This terminal, when completed, will be one of the first installations in the world specifically designed to handle the largest tankers likely to be built. Loch Long provides a sheltered anchorage with the necessary depth of water close to the shore.

Work is already in progress on a second jetty and on the auxiliary storage tanks. The jetty will extend 180-ft. into the loch, providing a depth at low water of 55-ft. Rate of discharge is expected to be up to 6,000 tons of crude oil per hour. The oil will then be pumped from Finnart through the existing 57-mile underground pipeline across Scotland to Grangemouth, where storage facilities to accommodate the greatly increased supplies of oil are being expanded at a cost of £6 million.

Electrical Installations in Large Dock Areas

With Special Reference to the Port of London*

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THERE has of recent years been a considerable increase in the consumption of electricity in large dock areas and at the same time the range of electrical plant which is being employed has been extended. Current high labour costs and other economic factors give rise to the belief that this process will not only continue but will accelerate in the future.

In applying electricity on a large scale many problems and difficulties arise. Some of these are inseparable from the use of power in large quantities, others are the result of unique operating conditions. The economic viewpoint is of first importance and it is necessary to re-examine traditional policies to determine their validity under the changed conditions. This article discusses some of these difficulties and describes steps which the Port of London Authority are taking to overcome them in the groups of docks for which the Authority is responsible.

Electrical Distribution

The traditional practice in most large dock areas is to distribute and use electricity in the form of direct current.

Direct current electricity supplies were first introduced into the London Docks in about 1880 when interest had been aroused in the possibilities of using electric lighting and this remained its principal field of application for about twenty years, although a few hand operated travelling cranes were converted to electric operation in 1894.

At first the electricity supplies were obtained from steam driven dynamos sited near to the load points but these were later superseded by supplies drawn from the public mains and introduced into the docks at intake points on the perimeter of the docks. Immediately prior to the First World War, high voltage networks were laid down by Supply Authorities but by this time the economical benefits to be obtained from using electrically driven pumps and the improvements in electrically operated lifting devices had resulted in the establishment of a considerable amount of D.C. operated equipment in the docks, frequently necessitating the use of rotary converters for conversion of high voltage A.C. to D.C.

In the early days distribution was effected by means of bare overhead lines or poles or on insulated brackets mounted on the roofs of high buildings. Services were connected through fused switches or directly to the intakes or small switchrooms. This was an arrangement of great value in a dock area where numerous small dispersed services have been and still are needed and where the distribution network may need to be modified as trade and electrical demands change. The element of fire risk and danger to maintenance workers where the bare conductors pass across the roofs of high buildings, the risk of damage from modern mobile cranes and the heavy cross-sectional area of conductors needed for long feeders are among the unsatisfactory features of this traditional system which have become increasingly apparent as the load has risen.

The task of maintaining the ageing installations, coupled with the difficulty of obtaining additional D.C. supplies from the public mains and the high capital cost of new conversion plant have made it necessary to devise new methods of distributing power and to introduce A.C. operated machinery where possible.

Gradually, medium voltage A.C. underground cable networks have been installed to overcome these difficulties and to supply the increased demands for electricity. Recently these demands together with the increased size of individual items of plant have produced a number of separate, compact, heavily loaded areas in most docks which cannot be economically supplied at medium voltage; accordingly in many areas high voltage distribution has been adopted with transformer or rectifier substations located at centres of load.

The high voltage systems adopted usually have the basic form of a ring main. Where the Supply Authorities have been willing to provide high voltage supplies at several convenient points on the perimeter, the interconnecting ring main lies outside the docks and is owned by the Supply Authorities. High voltage cables may then be laid within the docks to areas of heavy load and there transformed to medium voltage A.C. or converted to D.C. by mercury-arc rectifiers. Certain large items of plant, such as pumps, may be supplied directly at high voltage.

Where supplies have been made available at only one point on the dock perimeter a high voltage ring main has been established by the Port Authority within the dock area and this may be operated open or closed depending upon the arrangement of the medium voltage network and the protective relay system employed.

With either system several advantages are readily apparent.

High-voltage Switchboard in a recently constructed Substation.

Supplies may be purchased in bulk at favourable rates, the distribution losses and capital costs are low; stand-by facilities are easily provided, particularly where the medium voltage network is in the form of a ring main; additional substations may be established as new load centres arise and the use of 3 phase cables for secondary distribution ensures more economic use of heavy cable sections.

At substations established by the Port of London Authority 11,000/415 volt low loss distribution transformers of 500 K.V.A. capacity are common and oil or air circuit breakers are used to control the medium voltage distribution. Medium voltage cables are generally interconnected through links at distribution pillars; services and sub-mains are also connected at these distribution pillars through fuse links, whilst very large services are supplied at medium or high voltage direct from circuit breakers in the substations.

The type of protection gear which is employed depends, of course, on the distribution layout and the discrimination time which is available at the supply point. Normally inverse definite minimum time earth fault and overcurrent relays are used and patent unit protection is provided for the high voltage ring cables. On occasions difficulty has been experienced in obtaining sufficient discrimination time between the Port Authority's

*This article is based on a lecture delivered to the Association of Supervising Electrical Engineers in London on 30th January 1958.

Electrical Installations—continued

circuit breakers and the Supply Authority's circuit breakers controlling the incoming supply. In these cases considerable ingenuity has had to be exercised and reactors introduced into the ring main, whilst instantaneous earth fault relays, high set overcurrent relays and balanced earth fault relays have also been employed. Cartridge type fuses are extensively used on medium voltage services and on individual items of equipment.

The bulk of the power is, however, distributed throughout the Port of London Authority's Docks in the form of D.C. and this is likely to continue for many years in view of the quantity of D.C. plant in service and the extensive underground cable networks which have many more years of useful life. As it has become difficult to obtain additional D.C. supplies from the public mains the present tendency is to restrict the D.C. load to items of plant which cannot be replaced by A.C. operated machinery because of expense, service life or superior performance and to transfer lighting and heating loads to A.C. networks where it is not unduly costly to do so. Where additional conversion plant is necessary mercury-arc rectifiers are being installed to take advantage of their high efficiency and low maintenance requirements. The high capital cost of the latter equipment coupled with the conversion and distribution losses inseparable from the use of D.C. cannot be avoided at the present time. The development of the new semi-conductor rectifiers for power purposes, in particular the silicon rectifier, is being carefully watched in view of their possible application as unit rectifiers.

Lighting

It has already been noted that the earliest application of electricity in the dock areas was to provide electric lighting and even to-day this still represents one of the most important uses.

In general, the filament lamp is employed in the Port of London Docks in view of the low intensities usually required and the small number of hours that the lighting is in use. Where possible, installations are connected to an A.C. supply to keep the running costs to a minimum by eliminating the cost of the conversion losses and the capital charges on the conversion plant. It is also possible to use discharge lamps with their high efficiency, and light output, where circumstances warrant it.

Recent studies have shown that where low intensity lighting is in use for less than 1,000 hours per annum, the saving in consumption is usually outweighed by the higher capital cost of these types of light unit. For indoor use, where high light intensities are needed or where the number of hours in use exceeds this figure, it is frequently economic to use tubular fluorescent lamps and these are being introduced in offices and other places where good levels of illumination are required and in machinery houses or battery charging stations where night working is common. Substantial economies in installation costs have been effected by using high output lamps in large buildings such as storage or transit sheds where sufficient mounting height exists and where the structure allows a prefabricated trunking system to be erected comparatively easily.

The intensity of lighting provided inside buildings, varies widely and is of course related to the work carried on there. Certain commodities such as timber may be stored under cover for long periods without disturbance and simple low intensity lighting of the aisles between the timber stacks suffices. Other goods passing through transit sheds or warehouses may be handled by mobile diesel, petrol or battery-electric trucks and a minimum general illumination level of 3 l.m./sq. ft. is considered necessary for safe working. In some instances goods are sorted, weighed and measured on arrival or before despatch and intensities up to 15 l.m./sq. ft. are needed over areas where the visual task is severe. In machinery houses and workshops, a statutory minimum intensity of illumination is laid down by the Factories Act and intensities of 6 to 10 l.m./sq. ft. are usual in these places. Offices, canteens and similar buildings are generally lit in accordance with the I.E.S. code and due regard is paid to the quality of the light.

The standards described may easily be attained in new buildings and with the co-operation of the building designers, the electrical engineers can often find it possible to effect economies in installation costs. The real problem, however, relates to the difficulty in improving the standard of the installation in the older buildings. Many of these have an installation 30 or 40 years old which was designed when localised, low intensity lighting was accepted practice. These installations are now due for replacement in view of their age and the deterioration in

Interior lighting of Baggage Hall, No. 1 Shed, Tilbury Dock.

their condition. It is, unfortunately, difficult to design and install lighting schemes at low cost, based on modern principles, i.e. with a general uniform level of intensity. The size of some of these multi-storey buildings and the low mounting heights available for the lighting fittings, further complicate the problem. This question of re-lighting large, old buildings to modern standards is the subject of careful study at the present time, but its satisfactory solution may await the development of a cheap, high efficiency, low intensity, light source.

External lighting is required for police or security purposes, also at dry docks, on quays, at dock entrances and along access roads. In many cases the lights burn for 3,000 to 4,000 hours per year and where possible A.C. is being used to take advantage of the sodium and mercury-fluorescent discharge lamps in view of their high efficiency, long life and the resultant low maintenance costs.

As is well known, sodium lighting is the most efficient light source but gives poor colour rendering and it is difficult to work for long periods in the low average illumination intensities which results from its application. For these reasons, the colour corrected mercury-fluorescent lamp is being extensively used for the lighting of quays and other working areas with good results. For road lighting, the 140 watt sodium lamps having an average light output through life of 9,100 lumens are in use; some authorities consider it likely that this type of lamp has almost reached the limit of its development and that the 250 and 400 watt mercury-fluorescent lamps with 9,250 and 12,800 lumens light output may be more widely used for road lighting as they become cheaper and more efficient. In areas such as passenger berths where good colour rendering is desired the colour corrected mercury-fluorescent lamp is being employed.

The external quay lights are liable to damage by quay cranes and considerable ingenuity has to be displayed in selecting a suitable position for them which is relatively free from the risk of damage. They are usually mounted on the sides of sheds at about 30-ft. mounting height and 400 watt MBF/U 12,800 lumens colour corrected mercury-fluorescent lamps are frequently employed in weatherproof, outdoor pattern, floodlight fittings to provide the minimum average illumination of 3 to 4 l.m./sq. ft. at quay level which is necessary where mobile mechanical handling plant is used.

Entrance lighting has in the past consisted of 500 or 1,000 watt filament lamps in cut-off lanterns mounted on 35-ft. columns;

Electrical Installations—continued

here again the discharge lamp is finding an application and a recent installation consisting of 400 watt MBF/U lamps in outdoor floodlight fittings mounted 25-ft. from ground level appears to give satisfactory results.

Police lighting usually takes the form of a skeleton installation employing filament lamps in simple multi-mirror reflector fittings. The 80 watt MBF/U lamp with its high output of 2,480 lumens, a figure comparable with the output of a 150 watt filament lamp, has a higher efficiency and long life. This light source appears to have attractive possibilities for police lighting, as the latter is in use for about 4,000 hours per year but so far it has not been employed by the Port of London Authority for this purpose, because of doubts about security during the dark period associated with the process of lighting up.

The provision of temporary lighting on board ships when cargo is being worked is peculiar to docks and is worthy of special attention. Where D.C. supplies are used the voltage to earth does not exceed 250 volts and mains voltage is acceptable. Now that A.C. supplies are being widely used with a peak voltage to earth of approximately 340 there is a consequent increase in shock dangers. Double wound transformers having 110 volt secondaries with the centre point earthed are being installed for temporary cargo lighting supplies. The 55 volts R.M.S. to earth is considered to be safe under almost all conditions. Similar transformers are being introduced where A.C. portable tools are in use as recommended by H.M. Inspector of Factories.

In all lighting installations, the efficiency falls off rapidly unless reflectors are cleaned and defective lamps replaced at regular intervals. Many thousands of lights are in use in the Port of London Authority's docks, and about 20,000 lamps are purchased annually, indicating that lighting maintenance is a task of some magnitude. The long life and high output associated with discharge lamps will certainly reduce the maintenance required and on road lighting where the number of burning hours per annum approaches the guaranteed life of the lamps it is thought that block replacement, as frequently adopted by local authorities, may prove advantageous. The cost of replacing damaged lighting fittings is appreciable and in transit sheds where mobile cranes and trucks operate the number of lighting fittings damaged may often be reduced by careful selection of

Interior of Impounding Station, Royal Albert Dock.

the mounting position. Where standard dispersive or high level lighting fittings are used in conjunction with filament lamps the unit is inexpensive and the cost of a replacement fitting may be exceeded by the labour cost involved in doing the work. With fluorescent fittings the converse is often true.

Pumping Plant

For the considerable amount of pumping plant which performs important functions in large dock areas it is usual to provide spare pumping capacity and duplicate electricity supplies in order to guard against equipment failure and to facilitate maintenance. The pump motors have high or medium voltage windings, the former being preferred for motors of 350 h.p. or over. Slip-ring machines or squirrel-cage machines with direct-on-line starting are employed with power factor correction by capacitors; in some instances synchronous machines are in use and these are fitted with D.C. exciters.

In a typical impounding station 70 to 100 million gallons of water are impounded daily. If the amount of silt in suspension in the water varies with the state of the tide it is clear that the duration of pumping will be an important factor in reducing the cost of dredging the docks. The economic use of plant and the maximum demand charges set a limit to the reduction in impounding time.

These considerations had an important bearing on the design of an impounding station recently commissioned in one of the Port of London Authority's dock areas.

In this station four pump units are installed, two of large capacity driven by 540 h.p. 6,300 volt, 3 phase slip-ring induction motors and two smaller units powered by similar motors of 370 h.p. The motor speed of 740 r.p.m. is not the optimum for the pumps and speed reducing gear-box units are employed. Rotor resistance control is used for motor starting; an automatic motor-driven liquid starter controlling the rotor circuit external resistance. Power factor correction is by means of capacitors and heaters fitted to the motors to prevent condensation on cold windings. These heaters are automatically energised from a 240 volt A.C. supply when the motors are switched off.

Each pump motor may be controlled locally or from a remote control station approximately two miles away by means of supervisory control equipment; the two stations being interconnected by means of telephone pilot lines. Interlocks are provided to prevent starting with unsafe suction, low culvert water level or under other fault conditions.

For de-watering dry docks large pumps similar to the ones just described are in use and the electrical installations are much the same. In one of the groups of docks in the Port of London the impounding pumps, because of their excellent performance when pumping against a low head, are used in the initial stages of dry-dock de-watering. This is not a usual arrangement but where it can be adopted results in the greater utilisation of plant with a consequent increase in working efficiency and lower capital costs; it is of interest in view of earlier remarks on impounding pump size, duration of pumping and maximum demand charges.

Where power is distributed as D.C. the pump motors must be suitable for this supply but the more robust A.C. drive is gradually replacing D.C. operated units as the latter reach the end of their life.

Small D.C. or medium voltage A.C. motors are installed at dry docks to deal with seepage water and these are usually automatically controlled by float switch devices.

As much heavy dock machinery is still hydraulically operated electrically driven hydraulic pumping plant is still important in many large dock areas. The hydraulic pressure is generally maintained by accumulators situated near load points and at the pumping station. Changes in accumulator level are relayed to the pumping station and the output of the pumps is varied automatically. In the older station variable speed D.C. motors were used and speed changes effected by rheostatic control; in later stations where constant speed A.C. motors are used means have been devised to vary the pump output.

In a recently constructed hydraulic station the equipment provides for fully automatic pumping regulated according to the demand. In addition to complete protection of all the equipment, remote control of the installation is effected over a supervisory control system from a control station about three miles away.

Two pump units are installed, each driven by a 180 h.p. squirrel cage motor which are started direct-on-line. The motors are started off-load; the pump being disconnected by emptying the

Electrical Installations—continued

fluid coupling, the latter is then filled with oil automatically at a pre-set time after the motor has started. Limit switches are fitted to the accumulator which control the accumulator level between the upper and lower limits. The lower limit switch starts the motor whilst the upper switch controls the emptying of the coupling. The motor continues to run light for a few minutes after the coupling is emptied so reducing the frequency of motor starting. The oil for the fluid coupling is passed through a water cooled heat exchanger which dissipates the slip power during starting and also the full speed losses during running.

Normally one pump is sufficient to maintain the accumulator level between the limits prescribed; in the event of heavy load demands causing a continued fall in accumulator level additional limit switches operate to bring the second pump into service.

In addition to the main pumps a drainage pump is provided and controlled automatically by a float switch device in the sump.

Comprehensive protection and indication facilities are provided. In addition to the usual undervoltage, over current and single phasing and earth leakage protection, the bearing temperatures and temperature of the fluid in the coupling are continuously monitored. Failure of suction head, indicating loss of inlet water, is automatically indicated.

Many alarms and indications are provided, and repeated in the remote control station.

Quay Cranes

The most important item of cargo handling machinery in the Port of London docks is the quay crane. Over the past 50 years electrically operated quay cranes have progressively replaced the earlier hydraulic cranes. At the present time about three-quarters of the 600 quay cranes in the Port of London Authority's docks are electrically driven.

The standard 3 ton level-luffing portal quay crane has been widely adopted and this has an outreach of 65 to 80-ft., a hoisting speed of about 240 ft./min. and a luffing speed of 120 ft./min. with a 3 ton load. In post war years 5 and 7 ton cranes of this type with outreaches of 80-ft. or more have made their appearance at London and elsewhere. The Port of London Authority have adopted the 5 ton level-luffing portal quay crane as the standard heavy duty crane and the ones in use have a hoisting speed of 200 ft./min. and a luffing speed of 60 ft./min. on maximum load.

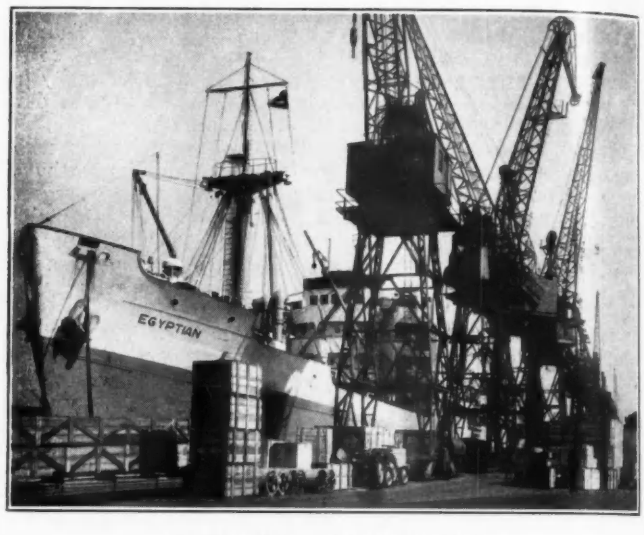
Many of the older cranes in the Authority's docks have drum type controllers with contactor panels for hoist and luff. Maintenance of drum type controllers is a considerable item and in later models the joystick pattern cam-operated master controller has been introduced which should result in a reduction in the amount of contact dressing. The luff and slew controls have been combined and a separate but similar controller is provided for the hoist motor.

The modern D.C. cranes have been fitted with a pilot-motor-driven master control relay operating on the hoist and luff motions and giving automatic notching of the motor. The maximum rate of acceleration of the main motor is limited by the pre-set maximum speed of the relay pilot motor; a load sensitive relay is used to vary the speed of the latter.

By adopting this arrangement the fastest safe handling speeds are automatically selected over the extreme range of loads, the crane driver whilst unable to affect the maximum rate of acceleration or deceleration still retains control of the maximum speed which may be attained by the hook. In consequence the power is always supplied smoothly to the motor at a pre-selected rate which is unaffected by poor driving and results in increased brush and commutator life and reduced maintenance.

The difficulty of obtaining additional supplies of D.C. power from the public mains has led to the introduction of A.C. operated quay cranes in certain dock areas where additional rectifier plant and costly D.C. mains would be required. As the existing D.C. distribution networks are replaced by medium voltage A.C. networks it is likely that more of this type of plant will be introduced. In one dock area where the D.C. mains are being completely withdrawn a number of A.C. quay cranes will be erected and the D.C. cranes which are serviceable and scheduled to remain will be fitted with unit rectifiers of the glass bulb mercury-arc type. This may be the forerunner of similar installations in other dock areas.

The main advantage of D.C. motor drives for cranes lies in the ease with which variable speed control may be obtained and it is usually necessary to adopt special arrangements when using



Quayside Cranes, West India Dock.

standard A.C. slip-ring induction motors. Speed control for luff and slew is generally obtained by the use of contactors operated by the joystick controller which varies the resistance of the rotor circuit of standard slip-ring motors. For the hoisting and lowering motions special arrangements are necessary. In one scheme which has been employed successfully two slip-ring machines are employed.

The larger of these two motors is rated at 75 per cent. of the normal motor h.p. and is geared to run the hook at the crane's rated speed. The smaller motor is 50 per cent. of the normal h.p. and runs the hook at twice the rated speed. The small motor may drive the hook in either direction but the large motor is always connected to run in the hoisting direction.

When the lowering motion is in use the main motor has its rotor open circuited and thus exerts no torque. The small motor drives the hook down and as the speed of lowering increases the main motor rotor voltage rises causing voltage sensitive relays to operate contactors which introduce rotor resistance in successive stages. The opposing or retarding torque thus produced by the main motor prevents overhauling whilst the maximum value of the speed depends upon the settings of the voltage relays and the position of the master controller.

During hoisting the main and small motors assist each other, but the smaller motor has rotor resistance in circuit which limits its speed so that it corresponds with that of the main motor. Creeping notches and some plain rotor resistance stages are provided. With light loads or empty hook a load relay operates, cutting out the main motor and automatically accelerating the small motor so that hoisting occurs at twice normal full load hoisting speed.

Whilst it is still early to give a definite opinion it is confidently expected that the electrical maintenance required by these A.C. cranes will be much less than with corresponding D.C. plant. The cam-operated master controllers perform only light duty and the maintenance of slip ring motors compares favourably with D.C. machines. As the contactors make and break A.C., the duty is less severe and very infrequent attention should suffice. The effects of bad driving are almost eliminated and this should reduce the amount of maintenance needed.

Electrical Installations — continued

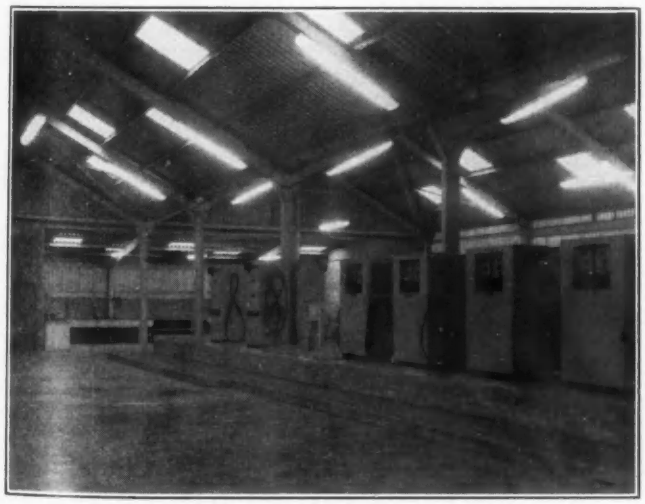
Electric Vehicles

In handling cargo from quayside to warehouse and between warehouse and the vehicle which is to move it away from the dock area, mobile plant has been employed in increasing quantities in recent years. The high capital cost involved in mechanising a cargo berth, the variety of plant required to deal with a wide range of commodities and, not least, the need to preserve good labour relations in what is traditionally a manual labour industry, all have their effect on the rate at which mechanisation proceeds.

In the process of mechanisation of cargo handling the battery-electric vehicle plays a part. Although generally cheaper to maintain than its diesel or petrol driven counterpart, it is usually slower. Its speed may be increased only by correspondingly reducing the number of working hours between battery charges and it is already difficult with some battery-electric trucks, to obtain a full day's work without a change of battery. For this, and other reasons, few mobile cranes in use in the Port of London Authority's docks are battery-driven.

A number of heavy duty battery operated fork-lift trucks are in use in the docks and these have a capacity of 1 to 2 tons. The power supply is obtained from a lead-acid battery of 14 cells with a capacity of about 360 amp hours at the 5 hour rate although some larger trucks have 560 amp-hour batteries.

The electric motors are of the totally enclosed type and some manufacturers offer motors with silicone insulation on the armature and field coils. The travel motor is series wound producing high tractive effort at low speeds and propelling the machine at about 5 m.p.h. The lift and tilt actions are usually obtained through a hydraulic system, a compound wound motor being used to drive the hydraulic pump. Control of both travelling and lifting motors is by means of contactors. A foot operated master controller operates the contactor for the travel motor and up to four forward and four reverse speeds are obtainable; a separate lever is engaged for reversing. Starting and stopping of the lifting motor is effected from the hydraulic control handle or handles, a switch on the valves closing the pump motor contactor. Brakes may be hydraulic and foot operated; a mechanical hand brake is provided for parking purposes.



Truck Battery Changing Station, Royal Albert Dock.

The battery-driven platform truck is the most common and widely used vehicle in the Port of London Authority's docks. About 150 of these vehicles are in use, most of them have a capacity of 2 tons and possess a loading platform 8-ft. long by about 4-ft. wide; in some models, the driver stands to one side of the centre line to give an extra space which is often useful when carrying long loads. The truck, which has three forward and reverse speeds, moves at about 5 m.p.h. and operates off a 28 volt battery having a capacity of about 320 ampere-hours at the 5 hour rate.

The tractive effort is obtained from totally enclosed series wound motors directly coupled to the driving axles. Speed control is obtained by series parallel field control and the speed is selected by operation of a drum type controller. A quick make and break contactor is fitted which is worked by a foot pedal and interlocked with the controller.

The machines are robust, efficient, easy to drive, highly manoeuvrable and require little maintenance.

In the large dock areas, mobile canteen vehicles are used and about 20 of these are battery operated using 72 volt 224 ampere-hour lead-acid batteries. An enclosed, ventilated and protected series wound traction motor provides the drive and speed control is by means of a solenoid contactor operated by an automatic delayed action foot switch; a separate reverse switch is provided. The vehicle travels at about 12 m.p.h. on the level and covers about 30 miles between charges. Head lights, side and tail lights are fitted and an ampere-hour meter is standard. The electrical equipment on these vehicles has reached a high stage of development and like the other electrical vehicles they are robust and reliable, although a minor disadvantage is the comparatively low speed.

In examining the economic factors arising out of the introduction of electric vehicles the cost of providing battery charging facilities cannot be overlooked. In general it is necessary to provide centralised battery charging stations at convenient points in the areas in which groups of trucks operate. To offset this cost it is usual to carry out battery charging at night, for in an area such as a dock, where peak power demand occurs during the day, the cost of battery charging at night is related solely to the k.W.H. charges. With an electricity tariff having a steady reduction in cost per k.W.H. as the load factor improves, the night load becomes more and more economic.

Remote Control and Supervisory System

The increased complexity of electrical installations has led in recent years to the extensive use of automatically controlled equipment with safety features incorporated in the design. As the cost of labour has risen economies in its use have been effected by presenting essential information on the working of such plant together with indications of faulty operation and control facilities at central points where highly skilled workers or supervising engineers are stationed.

In preceding paragraphs it has been noted that the latest hydraulic and impounding stations in the Port of London docks have been designed for fully automatic operation and the provision of remote control and supervisory features. Similar indication facilities are being included in the designs for new high voltage ring main distribution networks and it is likely that in due course the largest of these will be remotely operated from a central control room.

Two distinct types of remote control and supervisory systems are in general use varying widely in scope, application and design.

The first of these arrangements is the direct-wire system in which a separate wire or cable core is required for each signal transmitted. The voltage of operation may be as high as 240 volts but modern practice is to use multicore cables of the telephone type and to restrict the operating voltage to 50 volts. This allows the use of highly reliable telephone relays and associated light current apparatus and permits control of heavy currents to be effected by means of small interposing relays and contactors. The small currents required for relay operation permit the use of light cable sections and in the Port of London Authority's installations 20 pair multicore cables with 20 lb./mile conductor are being employed. The paper insulated lead alloy sheathed cable, possibly with wire armouring and bitumenous serving has been largely supplanted by polythene or P.V.C. insulated, single wire armoured and P.V.C. served cable because of the lower cost, lightness and non-hygroscopic properties of the latter type. The early difficulties associated with the jointing and termination of thermoplastic cables can now be said to have been overcome.

Electrical Installations—continued

The direct-wire system is simple, reliable and relatively cheap to install, particularly if, as is usual, the pilot cable can be laid at the same time and over the same routes as the high voltage cables.

With a 20 pair cable laid in the form of a ring the number of controls or indications which can be relayed to the central point approaches the number of cores in the cable, i.e. about 40. If the cable is not connected to form a ring or is opened at the remote end the possible number of indications and control signals which may be transmitted is approximately doubled.

In the case of switchgear it is usual to indicate switch positions open or closed and if remote operation for closing and tripping is required at least four pilot cores will be needed for each switch. There is, of course, a limit to the number of indications and operations which may be carried out on a direct wire basis using a multi-core cable of economic size. This is frequently reached much sooner than was expected when the system was laid down as additional facilities and alarm features are usually added to improve or extend the system.

To meet this position the second type of remote control and supervisory system was developed which utilises a number of trains of impulses forming a coded system. Each signal has its own code and a number of codes may be transmitted over one pair of pilot cores. The normal telephone dialling system is an example of this arrangement where the act of dialling a subscriber's number involves the despatch of a series of impulses along the telephone cable cores.

A coded system requires more costly apparatus than a direct-wire system but a smaller pilot cable will suffice for many dozens of signals and it is frequently possible to use pilot lines rented from the Post Office instead of incurring the capital cost of laying a multi-core pilot cable.

Both direct-wire and coded systems are in use or planned for installation in the Port of London Authority's docks. The direct-wire system will be employed for indication of high voltage switchgear positions and the operation of protective relays in substations; pilot cores will also be available for use with portable telephones for communication between the remote control room and the substations in the event of a fault occurring or during routine maintenance work. At a later date if it is decided to extend the network or to provide remote operation of switchgear, the number of pilot cores in the cable will prove inadequate but a simplified and limited coded system is commercially available which may be installed to increase the number of supervisory controls and indications that can be transmitted over the 20 pair, 20 lb./mile telephone cable.

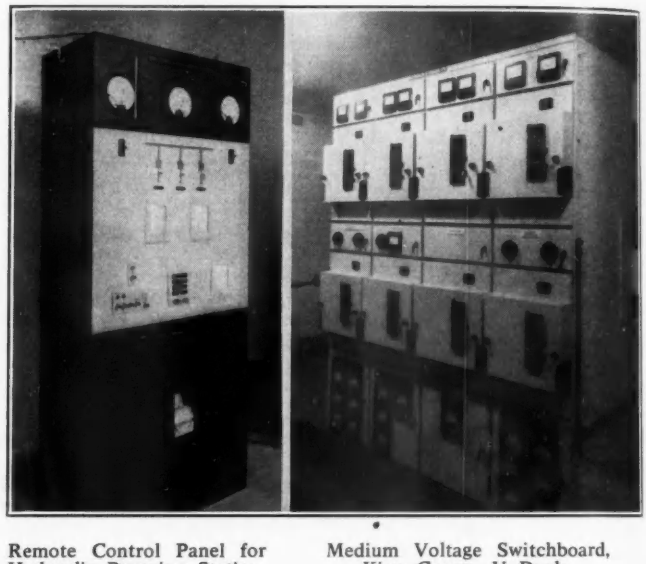
The coded system is in use at both the latest pumping stations for control of impounding and hydraulic pumps. In both cases coded impulse trains are transmitted from the pumping station to the central control point or vice versa. The impulse trains comprise normal and reversed polarity impulses, the total number of which is kept constant for any particular installation; the sequence and number of normal and reversed impulses is, however, varied to provide the discriminating code.

The system is extensible in groups of 24 controls or indications to a maximum of 576 using one pair of pilot cores. It is a feature of such systems that it provides for a "selection-before-operation" sequence to safeguard against accidental or incorrect operation.

When it is desired to perform a control function on a device the remote control panel is operated causing the train of impulses associated with the device to be transmitted to the other remote station where they are counted by rotary selection switches. If the number of impulses in the train is correct an illuminated indication is given at the control station. The operation is then carried out by pressing the control button for "start," "stop," "close" or "trip" as appropriate. A signal is then transmitted to operate the remote interposing relays and effect the control operation. Indication that the operation is complete is relayed back to the control room.

Alarm or fault indications are given by impulse trains originating at the pumping station and lighting the appropriate alarm plaque on the control station panel at the same time operating an alarm bell. The latter may be silenced when the supervising engineer operates the silence key but visual indication remains until the alarm condition is removed. Should the alarm impulse train be incorrectly transmitted due to interference it will be repeatedly transmitted until correctly received.

At the central control station a control and mimic diagram panel is installed which carries the alarms, indication lamps and control keys. In addition the use of current transformers in motor circuits enables the pump motor current to be displayed on an ammeter. Special current transformers are necessary to reduce the current in the pilot cable to an acceptable low value. A selection switch is provided which enables the metering connections to be made to the appropriate pump motor over the supervisory control equipment. Other devices transmit details of the hydraulic accumulator level and pump discharge pressure, the latter being recorded on a continuous chart recorder.



Remote Control Panel for Hydraulic Pumping Station.

Medium Voltage Switchboard, King George V Dock.

Radio Telephony

Soon after the end of the Second World War experiments conducted with the object of improving ship to shore communications on the River Thames led to the establishment by the G.P.O. of a radio-telephone service linking ships in the river and the national telephone network through a shore based radio transmitting and receiving station. This proved so useful to the Port of London Authority in conducting port operations that it decided in 1952 to set up its own private radio-telephone system solely for this purpose. The service has expanded and now an extensive installation exists used by the River Service launches, salvage craft, tugs, floating cranes and the dredging fleet and by the shore based police and ambulance services.

There is a common station situated on high ground which houses the base station for the three main services, viz., Police, River and Dredging and which transmits messages received by land lines from the various control stations to the respective vessels or mobile land vehicles over the frequency channels allotted for this purpose.

Main and standby transmitters are installed at the central station for use by the Police Service and River Service and the main transmitter is installed there for use by the Dredging Service.

A central police information room is established at the Royal group of docks which supplies information and instructions to cars, motorcycle patrols and ambulances throughout the dock undertaking. In the event of failure of the main transmitter the standby unit is brought into service by remote switching from this Information Room over a radio link; in emergencies this radio link may be operated instead of the normal G.P.O.

Electrical Installations—continued

land line. Portable transmitter/receiver units are provided at each dock group for use with walkie-talkie sets or as temporary mobile stations. The equipment is amplitude modulated and operates at 99.4 m/c's in the band of frequencies reserved for use by Police, Fire and Ambulance services.

Control points for the River Service are established at Woolwich and at Tilbury connected by land lines with the central transmitting station, change-over from main to standby transmitter is available over land lines from Woolwich. Emergency units are installed at these control points and reverse frequency working guards against interruption to the service resulting from a land line failure. A number of river patrol launches are equipped with radio-telephone equipment, as well as salvage vessels and the Authority's inspection vessel "St. Katharine." This ensures that the Assistant Harbour Masters at Woolwich and Tilbury are kept informed of traffic and visibility conditions in sections of the river for which they are responsible and enables immediate action to be taken to remove dangers to navigation.

The control station for the Dredging R/T service is at the Marine Engineer's Office, Surrey Commercial Docks and it is from this point that the Dredging Superintendent or Marine Engineer directs the dredging activities in the enclosed docks and in the river. Land lines connect this control station with the central transmitter and also with the Surrey Commercial Docks Police office. After normal working hours the latter takes over as the base station to ensure that in emergencies the dredging vessels are in communication with a manned shore station.

At each of the five groups of docks a fixed short-range base station is located operating on its own channel and providing the Dockmaster with the facility for controlling floating cranes, dredgers and tugs working in his dock area. In order to effect an economy in the number of frequencies employed, London Docks and Tilbury Docks use the same channel but the limited range of the transmitters prevents radio interference between the two stations. The tugs, dredgers, and floating cranes which may move from one dock group to another have multi-channel transmitter/receiver units capable of operating on any of the marine channels. The marine services operate in the band of frequencies between 158 and 164 m/c's and are amplitude modulated.

All the radio-telephones used by the Port Authority are of similar design. The mobile transmitter/receiver units, however, may be divided into three groups having R.F. power outputs of 1 to 2, 3 to 5 and 10 to 15 watts, the upper limits varying with the operating frequency. Equipment in each group varies in the facilities provided and the range of operating voltages. General requirements for the various services covered are met by each group and include single or double frequency Simplex, single or multiple channel working with operating voltages of 6, 12 or 24 volts D.C. and 100 to 150 or 200 to 250 volts A.C.

The circuits used in all three groups are basically similar employing a double superhet in the receiver section although some receivers are fitted with a crystal controlled local oscillator. All mobile units are fitted with an 8-pin socket for use with a standard test set which fully monitors the transmitter and receiver circuits. This enables field and routine tests to be carried out with a minimum of disturbance to the equipment or service.

Base station equipments have a double superhet receiver section which is basically the asme as that in the mobile units and in every case it is fitted with a carrier-operate mute relays. The power amplifier employs a twin tetrode push-pull circuit with an R.F. output of 10 to 15 watts. All the base stations can be arranged for local, extension or remote control.

In the latter case, D.C. signalling is used to switch power supplies and for transmit/receive operation. On double frequency services additional facilities are provided to enable "talk-through" operation or "ship-to-ship" working using the base station as a repeater. In this condition an extra pair of contacts on the carrier-operated mute relay in the base station are used to switch the transmitter. The control station still retains over-riding control and can monitor transmissions under the talk-through conditions.

Switching circuits use 50 volts D.C. and are two or four wire systems depending upon the facilities provided. Moving coil microphones are used and the gain of the line amplifier is arranged so that its output complies with G.P.O. regulations. The distance over which these remote control units can be satisfactorily operated is normally limited by the total D.C. loop resistance of the Post Office lines.

The system has in general operated satisfactorily and its value is indicated by the rapid growth of the installation in the past few years. The equipment used has proved to be robust, efficient, adaptable and reliable but the continuance of this good service is, of course, dependent upon the quality of the maintenance and adjustment it receives.

A radio repair workshop has been established for the maintenance of the main transmitting station, the nine base stations and the 96 mobile stations which are in use. This workshop is equipped with expensive test instruments and is manned by skilled technicians who carry out routine servicing and effect repairs. A planned maintenance system is being evolved which, it is expected will avoid the breakdown of radio equipment in service and ensure economic operation of the system.

Acknowledgments

The Author is indebted to the Port of London Authority for permission to use the information contained in this article and for the photographs which illustrate it. He is grateful to the Chief Engineer, Mr. G. A. Wilson, M.Eng., M.I.C.E., M.I.Mech.E., and to his colleagues who assisted in its preparation.

The Thames Navigation Service

New P.L.A. Scheme to Assist Shipping

Since 1948 the Port of London Authority has introduced progressively schemes for using radio-telephony to assist shipping and port operations. The original scheme was based on the Thames Radio Service of the General Post Office but in the light of technical developments, further schemes were introduced from 1952/55 embodying private systems for the Authority's river craft, police services and dockmasters. These schemes included the Authority's fleet of dredging and salvage craft, dock tugs and floating cranes. Provision was also made to include channels for shipping to communicate with the dockmasters at all of the five dock systems and with the Assistant Harbour Master, Tilbury Landing Stage. These private systems all operated with amplitude modulation.

During this period there were a number of international discussions as to whether amplitude modulation or frequency modulation should be adopted and it was not until July, 1955 that agreement was reached to use frequency modulation. International discussions then continued on the allocation of frequencies for Port Communications and it was not until 1956 that agreement was reached.

Concurrently a Working Party was set up in 1956 under the auspices of Trinity House to consider and report on the particular problems of asistance to shipping during reduced visibility. As a result of these deliberations the Authority have decided to introduce a scheme for the Port of London to be known as the Thames Navigation Service which it is hoped will be inaugurated in the spring of 1959.

Operations Room

This Service will function from an Operations Room which is to be erected at Gravesend, and will be under the control of the Harbour Master, Lower District. It will be manned continuously and will embody a network of communications to receive essential information which will be transmitted by radio-telephony frequency modulated, using frequencies allocated in accordance with the international agreement.

The system will comprise nine channels. The International "Calling and Safety" Channel No. 16 will be used by vessels

The Thames Navigation Service—continued

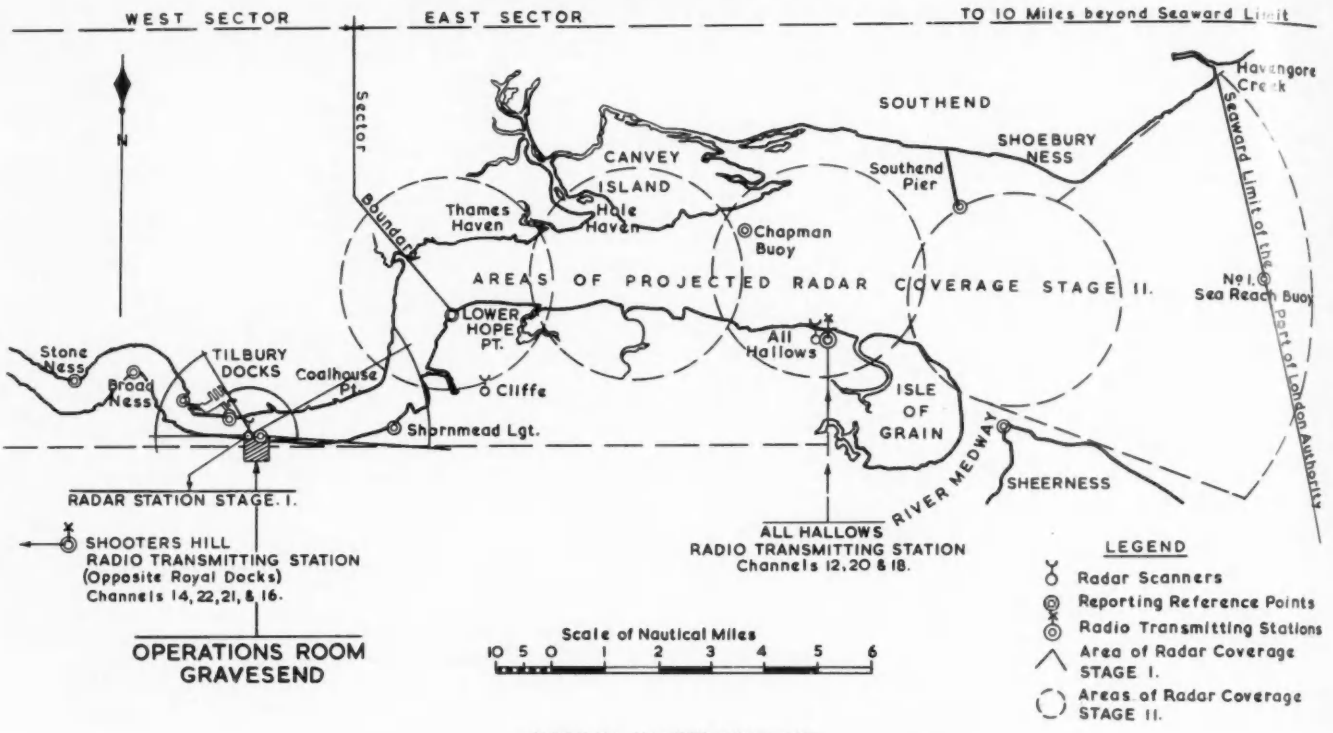


DIAGRAM ILLUSTRATING THE

THAMES NAVIGATION SERVICE

entering the port to make initial contact with the Operations Room. Thereafter, vessels will be told to switch to one or other of the remaining channels as directed by the duty officer on the following basis. The river will be divided into two sectors, the east sector extending from the seaward limit to Gravesend and the west sector from Gravesend to London Bridge.

Three channels will be allocated to the east sector, viz Channels 12, 20 and 18. The first, No. 12, is intended primarily for small vessels although it may be used by larger vessels when radio traffic is light. Channel 20 will be used for large vessels and Channel 18 will be used to supplement as and when necessary.

Three channels will be allocated correspondingly to the west sector, viz. Channels 14, 22 and 21, No. 14 taking over from No. 12 and 22 and 21 taking over from Nos. 20 and 18 respectively.

It is intended to commence operations on two channels per sector (viz. Channels 12 and 20 east sector, Channels 14 and 22 west sector) and extend the service to include Channels 18 and 21 when the volume of R/T traffic necessitates the additional facilities.

Channel No. 6 will be available for inter-ship communication. Channel No. 19 has been earmarked for use as a berthing frequency for tankers using oil wharves at Thames Haven, Shell Haven, Canvey and the Medway.

Channels 16, 6, 12 and 14 are simplex and Channels 20. 18, 22, 21 and 19 are duplex.

This allocation of channels is designed to cater for small vessels with only the minimum of R/T equipment. Such vessels could, if desired, operate on four simplex channels only, viz. Nos. 16, 6, 12 and 14; larger vessels will probably require at least eight channel sets which it is anticipated they will also require when using other ports at home and abroad. The use of two alternative channels for large vessels in each sector will avoid congestion.

The service will be of value at all times but particularly during periods of reduced visibility. In order to have the necessary data available the Authority intend to introduce radar to assist in providing this information. For this purpose a radar scanner will be erected on the Operations Room and will give surveillance of Gravesend Reach. (See Diagram—Stage I.) In addition, the harbour service launches covering the river from Erith to the seaward limit will also be fitted with radar.

This will enable the Operations Room during times of reduced visibility to have an appreciation of the volume of shipping in Gravesend Reach so that vessels can be advised whether to proceed up-river to an anchorage or to wait until accommodation is available. The scheme has also been designed so that radar coverage can be extended to the seaward limit if it be considered desirable in the future. (See Diagram—Stage II.)

The intention is to pass such navigational information as is common to all vessels on a broadcast lasting a few minutes once every half hour leaving the rest of the period available for ships to ask for any particular or supplementary information they may desire. The information required by the Operations Room will be obtained from the following sources:

(a) The Authority's harbour service craft will be in radio communication with the Operations Room and will supply necessary information regarding river navigation, including the state of reaches, visibility, obstructions, wrecks, dredging and salvage operations.

(b) The dockmasters will be in direct telephonic communication with the Operations Room and will provide their intended programme on each tide of vessels arriving and departing and report on local visibility.

(c) Harbour service piers and certain selected riverside wharves will also supply visibility reports.

(d) Special weather forecasts for the river and approaches will be obtained from the Meteorological Office.

(e) From the recording of readings from remote tide gauges and visibility recorders direct in the Operations Room, methods of achieving which are under consideration.

(f) The current situation in Gravesend Reach from the radar displays.

The scheme is intended to assist in co-ordinating the activities of all authorities engaged in shipping. These include pilots, H.M. Customs and Excise and the Port Health Authority. These bodies function from the Gravesend area and this is the primary

The Thames Navigation Service—continued

reason for the Operations Room being situated alongside the Royal Terrace Pier which is the pilot boarding station. Preliminary arrangements have been made for H.M. Customs and the Port Health Authority to be represented in the Operations Room building so that vessels can be boarded before arrival at Gravesend, thus expediting their passage through the Gravesend controls.

Within the Operations Room there will be a large scale panoramic plan of the river from the seaward limit to London Bridge. On this will be recorded and maintained the position of vessels lying at buoys and anchorages, the position of wrecks and obstructions, the degree of visibility at all points, the state of the tide and any other features of navigational significance. There will be a viewing gallery at the rear through which pilots can see the state of the river in all its aspects and discuss with the duty officer any particular problem before they proceed afloat.

The duty officers will know in advance of expected arrivals and departures. As vessels enter the port limits they will make initial contact through Channel 16, the main calling channel. Thereafter, through the appropriate port channels to which they will be directed, they can impart and receive precise information regarding draft, time of arrival at river berth or dock entrance. As they proceed up-river they can receive instructions as to the order of docking and if necessary can speak direct to dockmasters and can similarly receive direct instructions, the control switching of the radio channels being done by the Operations Room.

Considerable attention is being paid by the Authority to matters of radio procedure and radio discipline. Negotiations are in progress with other ports in the United Kingdom, who are establishing a comparable service, to endeavour to standardise a simple yet efficient radio communication drill for the benefit of the ship-master who uses a number of ports in the U.K. The radio channels have also been chosen so that as far as possible comparable information is provided on the same channels at all ports in the United Kingdom which operate a service of this nature.

The success of this new service will depend upon the extent to which shipowners install the requisite frequency modulated radio telephony in their ships.

Metallurgical Progress in Dock and Harbour Engineering

By J. LOMAX

In many fields of industry significant developments are merely reported as out-of-the-way notes or comments which describe the work done by research institutes or metallurgical laboratories in different parts of the world. For example, the modern permanent magnet industry largely owes its vast development in this country to an obscure paragraph in an odd corner of a technical journal, reporting the discovery of a new material by a Japanese research worker. This paragraph was noticed by an interested information officer, reported to senior technicians, and instantly appreciated as a development of enormous potential importance.

While the details of recent metallurgical progress that follow may not appear sensational or contain anything so exciting and influential as the above, they indicate directions in which advances are taking place, and should be studied carefully by the engineer for equivalent reasons.

Crack Detection

One of the most important requirements is the ability to detect cracks and other surface defects in metallic parts. The use of the fluorescent penetrant dyes for this purpose is not wholly new. The part suspected is studied under black light, but hitherto, because of improper process control, human failings and the limiting sensitivity of the penetrant, the process has not been regarded as 100 per cent. foolproof. The latest refinement, however, is the post-emulsion process, in which the components or parts are immersed in an emulsifier following the penetrant. This is claimed to give a much more trustworthy result.

For the cathodic protection of metals, such as steel piling, etc., against corrosion, a new magnesium alloy containing manganese has recently been introduced and is claimed to be superior to the usual alloys for sacrificial anodes. The new alloy will deliver from 20 to 30 per cent. more current to a polarised cathode. In saline soils there is also an advantage in current efficiency. Polarisation characteristics and corrosion distribution are similar to those of the conventional magnesium alloy, which contains 6 per cent. aluminium, 3 per cent. zinc.

Protection of Piling

The protection of steel piling in and above the sea has been effected by the use of vinyl paint in the atmospheric zone. In the most corrosive environment, which is the splash zone, a choice may be made between gunite, monel high nickel copper alloy or plastic jacketing, porcelain enamelling, sheet neoprene, flame-sprayed polyethylene, metallising, and plastic tapes or vinyl mastic over vinyl paint. For underwater protection, the method of cathodic protection with magnesium anodes is still preferred.

Tanks storing crude oil are liable to severe corrosion, and an attempt has been made to overcome this by the injection of anhydrous ammonia into the vapour space of the tanks. This, however, did not reduce the corrosion rate unless the steel was free from iron sulphide corrosion products. In these circumstances protection was afforded for about six months, but then, in the presence of hydrogen sulphide, the corrosion rate reverted to the normal value.

Flame Plating

A new technique is flame plating, which is a method of applying a hard, dense, wear-resistant coating to the surfaces of metals. A specially designed gun is loaded with prescribed quantities of metallic powder, acetylene and oxygen. The powder remains suspended in the explosive gas mixture until a spark ignites the mixture, producing heat and pressure waves, which set up a detonation wave. When this wave, which causes a rapid rise in pressure, leaves the barrel, the gases in the barrel rush out and the metallic particles, now partly molten, are hurled at high velocity at the piece to be coated. Although the gases reach a very high temperature, the piece is not overheated because of the rapid dissipation of the heat waves as they leave the gun barrel. The powders currently used are a mixture of tungsten carbide and another of aluminium oxide. Work is continuing on specific applications of the process and also on the development of new coatings with broad fields of application. The object of the plating is not to give greater resistance to corrosion or reduce oxidation, but to give hardness and wear-resistance.

Carbo-Nitriding

For providing a greater hardness on the surface of metals, formerly achieved by means of case-hardening or nitriding processes, a new development is carbo-nitriding. This is a process in which a ferrous alloy is heated in an atmosphere of such a character that it simultaneously absorbs both carbon and nitrogen, after which it is cooled at a rate giving the required properties. The absorption of nitrogen lowers the temperature at which important microstructural changes take place, slows down the rate at which these changes occur, and at low temperatures forms complicated iron nitrides. In these respects nitrogen acts in a manner typical of carbon in ordinary case-hardening.

In the combat against marine corrosion, the austenitic chromium-nickel 18-8 stainless steels have been found in many instances much too expensive, while since the extensive rearmament programme began, their heavy consumption of nickel has been a further handicap, since this is a strategic metal in relatively short supply. Research into the production of austenitic stainless steels in which at least half the nickel would be replaced by manganese has been going on for many years, but

Metallurgical Progress in Dock Engineering—continued

until recent times it was only the countries short of nickel, such as Russia and Germany, that paid them serious attention. Now, however, a range of new high manganese, low nickel stainless steels has been put on the market. Their production in the United Kingdom is only in test quantities at the moment, but in the United States their commercial employment has increased by ten times in two years. There are two main types, one containing chromium 17 per cent., nickel 4 per cent., manganese 6 per cent.; and the other, chromium 18 per cent., nickel 5 per cent., manganese 8 per cent.

Cathodic Protection

Reference has already been made to cathodic protection. Three large piers consisting of H-piles driven into rock have been safeguarded in this way. The impressed current systems were included in the original design of the structures. Provision was made for an alarm system to operate if the current in any circuit dropped below 50 amps.

Magnesium anodes placed inside a 10,000 barrel steel tank used since 1931 for temporary storage of crude oil, and the anodes covered with water, prevented internal corrosion of the tank bottom and lower sides, from which it had previously suffered severely. A coal tar coating and steam coils had not cured the corrosion, though they had retarded it.

Cathodic protection of submerged piles, driven into marsh or other difficult land for foundations of piers, etc., is being effected elsewhere by selenium rectifiers, manufactured by a British firm.

Pile driving is being controlled by a portable steamer of 125 h.p. One control provides fully modulating control from low fire to high fire for all demands. The steamer delivers 4,300 lb. of dry steam per hour, from cold start in 30 minutes. This dry steam is said to be the best source of power for pile driving. It gives full and double acting hammers full rating in maximum number of blows through the pile driving cycle. The equipment can also be used to provide steam for heating asphalt, winter thawing, cleaning plant, or for heating buildings.

Ordinary austenitic stainless steel continues to be employed in docks and harbours, where the corrosion of marine atmospheres is a heavy burden. The principal employments are for roofing, the use of which is on the increase; for gutters and downspouts of warehouses; for storm and screen doors and window screens; and for door-knob and lock assemblies, as well as nails, screws and other fasteners. It is an exceptionally good investment.

Air Drying

In recent years, the damaging effects of moisture and humidity have become increasingly apparent to docks and harbours. Excessive moisture causes condensation, with accompanying corrosion; mould formation; and peeled paint. Products deteriorate in storage. Employee discomfort is increased. In the last few years the problem has been solved in many instances by means of a control system drying air with the aid of a liquid chemical. The damp air passes through a contacting chamber, in which a lithium chloride spray absorbs the desired amount of moisture, as well as 97 per cent. of the air-borne bacteria. Moisture content of the air leaving the unit is governed by the temperature and concentration of the absorbent solution. The unit employs only two electric motors, a pump and a fan. Where the metallurgist comes in is in providing for the tubing an alloy known as cupro-nickel with segmented fins of solid nickel. The cupro-nickel withstands the corrosive steam and the nickel fins prevent galvanic action between the two metals, as well as providing good heat transfer properties. Shipowners have already used this system to dry up condensed moisture in tanker holds and keep them dry during the voyage.

Ultrasonic Welding

Another novel process is ultrasonic welding, one of the most significant advances in the application of ultrasonic energy at higher power levels. It has made possible the production of sound joints in metals and geometries which are difficult or impossible to achieve by other methods. The weld is made by holding the two pieces of metal to be welded with a force of between 10 and 350 lb., and simultaneously subjecting the two pieces to ultrasonic vibration. The process lends itself particularly to the welding of thin strip and fine wire. All metals are weldable by the process, though the very soft metals or alloys are sometimes a little more difficult to weld than the stronger.

The advantages of the process include no need for specially careful surface preparation; little deformation; lower applied static compressive loads. This process and also ultrasonic soldering and brazing are still in the development stage.

Foamed Aluminium

Foamed aluminium may replace wood in some construction applications if research work in an industrial laboratory proves successful. The material, slightly heavier than balsa wood, can be sawn, nailed, screwed, cemented or bolted. The product could potentially be made as cheaply as timber, it is claimed, and eventually might be used instead of it in some applications because of its resistance to corrosion and fire. Development is still in an early stage, and many problems remain to be overcome.

A method of discovering how tightly organic coatings adhere to metallic surfaces has been worked out by a British firm. A sample of the coating is painted on to a thin steel disc. This is fired much like a bullet at a specially designed steel target. The target has a hole at the place where the coated part of the disc hits it. Thus, the steel disc is stopped abruptly by the target while the coating continues on through the hole. The ability of the coating to stick to the disc is related to the speed of the disc before it hits the target.

A range of rigid-frame steel buildings, suitable for warehouses, stores or other buildings, can be obtained in any of three standard widths—40, 50 or 60-ft.—or in multiple units. They can be built in any length in multiples of 20-ft. The straight sidewall buildings consist of a tapered frame, roof structurals and roof panels. They are designed to give an unobstructed interior and have structural strengths to meet wind and snow load requirements. Accessories can be obtained.

Nodular iron is being used for the grates and frames of the drainage systems of many docks and harbours. This material has been chosen to ensure long life and low maintenance costs, by resisting breakage under shock, such as is caused when heavy vehicles pass over the grates and frames, and by giving good resistance to corrosion in atmospheric conditions. In one project alone, some 5,000 grates and frames of nodular iron have been used. The material is employed in the annealed condition.

Radar System for Hamburg Harbour

The Hamburg Harbour Commission is to equip Hamburg Harbour and the adjacent stretch of the River Elbe with four land-based radar stations. The contract has been awarded to Telefunken GMBH in collaboration with Decca Radar Limited of London.

The radar equipment to be provided is of the same type as that recently installed at the Port of Southampton. Similar installations are also being fitted at the Port of Liverpool and at Khandla in India.

With the aid of a radar link system to be supplied later, Hamburg Harbour will have the entire estuary and harbour region under observation from its central pilot station, which will be situated at Waltershof. Radar pictures will be presented from the following carefully selected stations: Altona Fishing port, Ness-Sand, Krusenbusch and Hohe Schaar, thus providing in one room a complete overall view of the harbour, which will be interpreted by operators with a precise knowledge of the locality. The masters and pilots of incoming and outgoing ships will receive information and advice by radio, independently of their own ships' equipments. They will be warned of the general traffic condition within the channel, of the berthing position and of any miscellaneous dangers which might otherwise be unrecognised. The range of the equipment covers the entire area of navigation, including all remoter parts of the harbour.

Modernisation of the Duquesne Dock, Dieppe

Conversion and Deepening of Fish Dock

By P. de CONIHOUT

IN spite of the fact that Dieppe, due mainly to its geographical position, has been an important fishing port for centuries, the special installations and facilities it possessed before the Second World War were found to be inadequate for its needs. Those parts of the port used by the fishing fleets—the southern end of the outer port, the small old Fish Dock and the oldest dock basin of the port, the Duquesne Dock—suffered from many defects. The water depths were hardly sufficient and the quayside aprons were too narrow; the access of the Duquesne Dock, by the Pollet channel and the inner port, was too long and awkward and in addition, considerable inconvenience was caused by the trawlers and the cargo vessels both using the same channel when proceeding to the new commercial docks to the east of the inner port.

The local authorities had long been aware of the situation at the port for, as far back as the year 1919, plans were made to remedy the problems but the complexities of the situation were such that the long interval between the two wars did not suffice to bring them to maturity. The detailed studies that were carried out, however, were not entirely useless for they gave a sound starting point for those undertaken later.

During the last war the whole of the fishing port was badly damaged, the quays at the southern end of the outer port being almost demolished, the old fish dock quays destroyed and the dock entrance gate, giving access to the Duquesne basin, rendered useless. Once again, therefore, the problem of the fish zone of the port necessitated urgent consideration.

Like so many of the old world ports of western Europe, the original centre of early growth was about the fish market which was usually the nearest level area for the landing of the fish from the boats. With the growth of industry and the natural increase of population the buildings of the town gradually grew up close to the dockside quays and indeed the fish zone, market and docks at Dieppe is not only surrounded by the buildings of the town centre but it is also traversed from north to south by a National trunk road (Fig. 1) carrying considerable traffic.

Since satisfactory solutions had been evolved for all these problems there was no need to re-open technical enquiries, except where necessary to meet the accelerated post-war modernisation of mechanical aids and the techniques associated with new materials. It was generally agreed that a floating dock was preferable to a tidal basin and it was further agreed that the eastern entance to the Duquesne dock from the inner port should be closed and that the traverse wall separating the Duquesne dock from the old fish dock should be demolished. It was obvious that if the old Fish dock were replaced by a ship lock, thus making the new dock available at all tides, this would be a great advantage to the fishing fleet. There was, however, one disadvantage. At times clapotis of inconvenient dimensions developed at the south end of the outer port and there was a risk of damage to the entrance gates. In order to avoid trouble from this cause it was decided that the outer entrance gates should be of the double leaf sector type on a vertical axis. Double leaf sector gates have proved to be better able to withstand mechanical wave shock than the ordinary V gates since all applied forces are transmitted through their points of suspension. Moreover, this type of

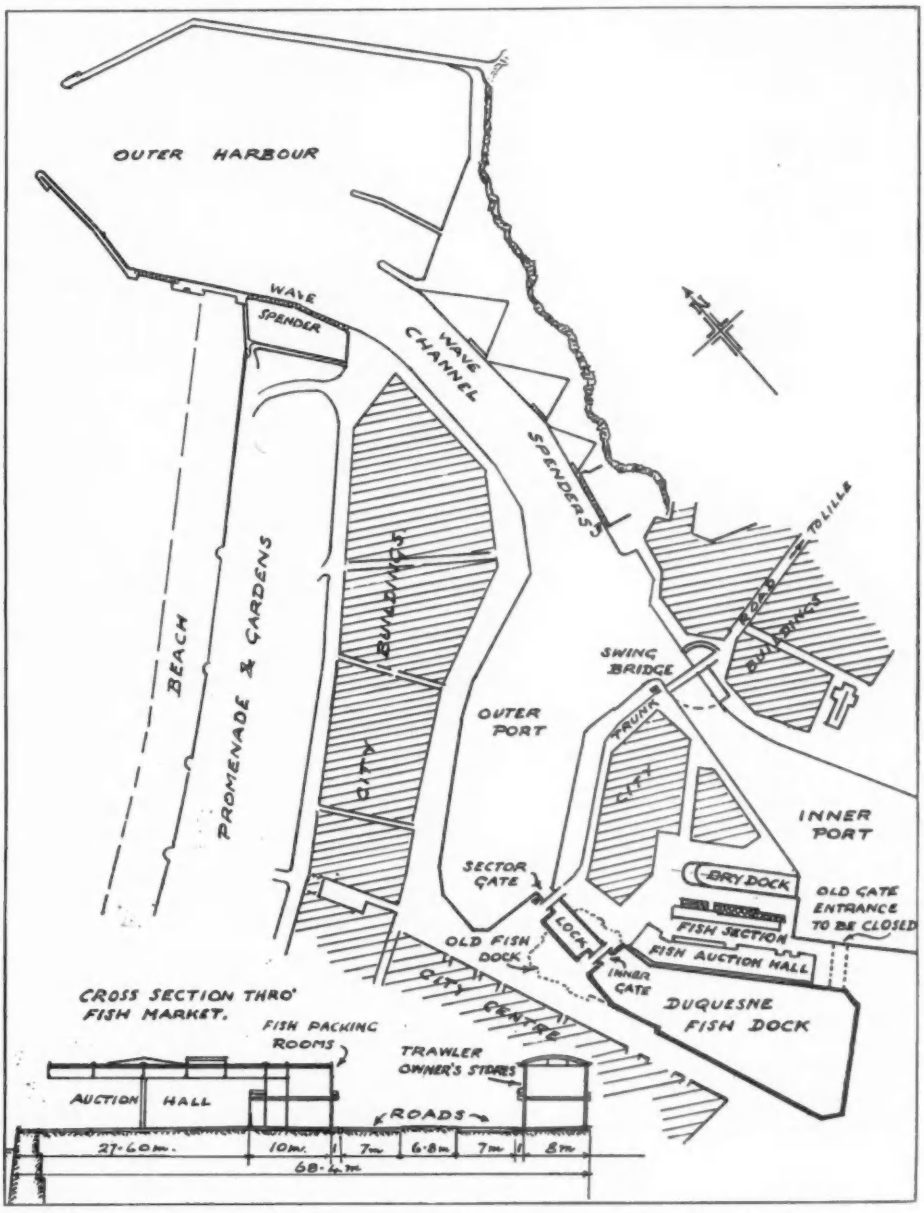


Fig. 1. Part plan of Dieppe port showing location of new fish dock and cross section of fish market.

Modernisation of the Duquesne Dock, Dieppe—continued

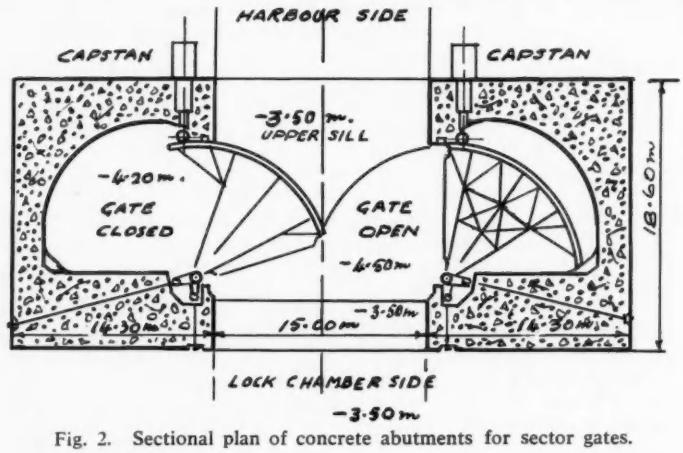


Fig. 2. Sectional plan of concrete abutments for sector gates.

gate has the further advantage of accelerating the operation of locking because they can be opened under partial load, which greatly facilitates the emptying of the lock chamber.

The entrance widths of the outer and inner gates are both 15 metres and the width of the locking chamber is 35 metres for a length of 60 metres. This represents an encroachment of about 40 per cent. on the water area of the old fish dock. The cill levels are shown in Fig. 2.

Description of the Works Undertaken

The first objective of the conversion work was the re-establishment of the Duquesne basin as a floating dock at all states of the tide—in contrast to the conditions existing where vessels were grounded in the mud at low tide. This necessitated:

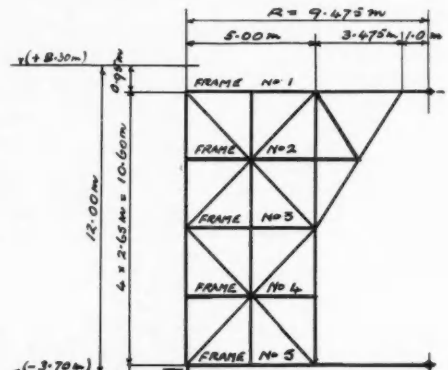


Fig. 3. Sector Gate. Arrangement of vertical trusses, points of suspension and cill height.

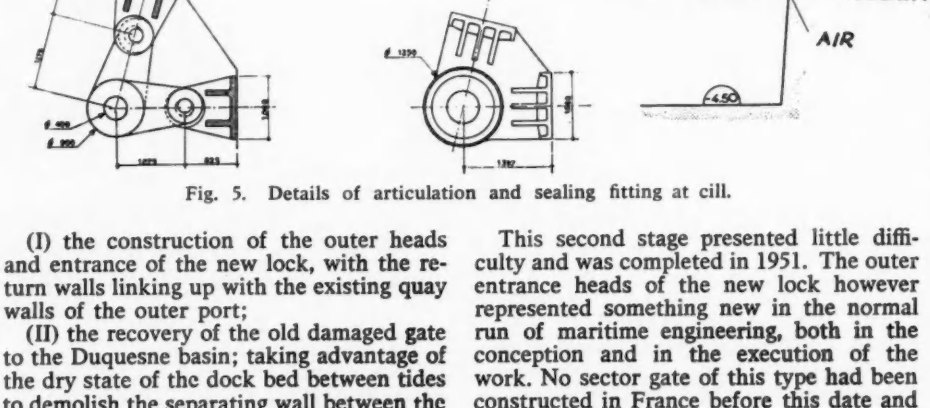


Fig. 5. Details of articulation and sealing fitting at cill.

(I) the construction of the outer heads and entrance of the new lock, with the return walls linking up with the existing quay walls of the outer port;

(II) the recovery of the old damaged gate to the Duquesne basin; taking advantage of the dry state of the dock bed between tides to demolish the separating wall between the two docks; and preparing the foundation work for the walls.

This second stage presented little difficulty and was completed in 1951. The outer entrance heads of the new lock however represented something new in the normal run of maritime engineering, both in the conception and in the execution of the work. No sector gate of this type had been constructed in France before this date and there was only one other example in course of construction, that at St. Malo*. The mass concrete abutments comprised a common apron and cill and two massive flank walls, shaped and hollowed out in a quadrantal form, as shown in Fig. 2, to the dimensions necessary to house the gate leaves in the open position and also to provide sealing, watertight borders.

Each gate leaf is constituted of a single uniform thickness ($\frac{3}{8}$-in. M.S. plate) of watertight circular panel connected to a framework of five horizontal trusses. These horizontal trusses transmit the forces to three vertical trusses which in turn transmit the loads to the articulated connections (Figs. 3 and 4). Normally the gates are in tension but can work equally well in compression if the level of the water in the lock basin is lower than the outside level.

The two hinge pins to each gate leaf are of robust proportions, the lower pins taking only the horizontal forces due to the water

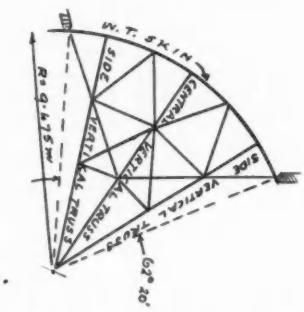


Fig. 4. Sector Gate. Arrangement of horizontal frames, arc of gate skin and pivot.

pressure, while the upper hinge pins take most of the weight of the gate (Fig. 5). These forces, 350 tons maximum in tension and 500 tons maximum in compression for the lower pin, are transmitted to the fixed parts by roller bearings. The hinge pins are of special design and exceptional dimensions and are housed in strong steel castings bolted to the masonry of the wall. They are further held by anchor ties of high tensile steel held in the concrete of the wall mass in the same manner as for pre-stressed steel reinforcement.

The upper articulation is held in double links bored out and pinned to allow for eccentric play, which assures a rigorous vertical axis, plumb central over the lower pin. The roller bearings are contained in oil-filled watertight cases, the watertightness being attained by the use of a mercury container in the form of a cylindrical cap. The casing can be supplied with oil whilst totally submerged.

An interesting feature of this type of gate is the manner in which the watertightness of the contacting perimeters of gate leaf to gate leaf, of the curved gate to the curved cill, and the vertical seal between each gate leaf and its corresponding abutment (side wall) is effected.

The right hand drawing of Fig. 5 shows a specially formed envelope of rubber, the

* See "The Dock and Harbour Authority," November, 1950, p. 227.

Modernisation of the Duquesne Dock, Dieppe—continued

edges of which are held in a frame of steel sections shaped closely to, and parallel to, the contours of the curved gate leaf. Between the frame and the rubber envelope there is an air chamber similar to that of an automobile wheel rim. The watertightness is obtained by the admission of compressed air into the chamber, thus forcing the outer rubber skin into close contact with the opposing sealing surfaces.

The manoeuvring of the gate leaf is effected by the use of a single steel cable, each end of which is secured at the extremities of the sector on the upper part of the leaf. The cable is wound round the drum of an electric capstan a sufficient number of turns to ensure controlled movement, the rotation of the capstan in one direction or the other operating the opening or shutting of the gate. The operation of opening the gate has been tested with a difference in water levels of 5-ft. but it is considered possible to increase this load without difficulty.

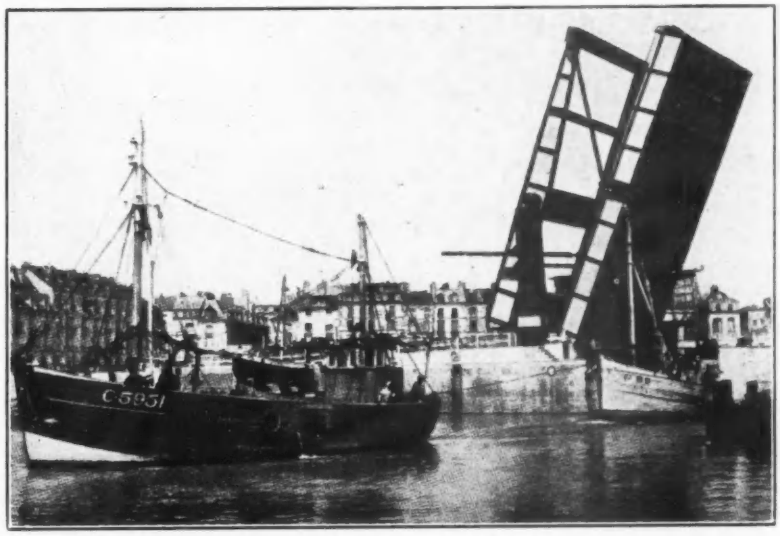


Fig. 6. Drawbridge and Sector Gates open to admit trawlers to new dock.

Draw Bridge

The equipment of the outer entrance of the lock was completed by the installation of a draw bridge. This bridge has a span of 65-ft., which is exceptional for a bridge of this type (Fig. 6). It is operated by a rack and pinion gear powered by the alternating 3-phase current supply of the local public distribution system.

Details of Construction

The construction of the works was carried out in a cofferdam formed by a single wall of steel sheet piles. The chamber was in the form of a rectangle 46 metres long by 21 metres wide, divided into three compartments, the two outer compartments being 17 metres wide and that in the centre 12 metres wide, corresponding to the flank walls and the entrance channel. Initially the Larssen V piles were ordered 20 metres long, but these were found to be insufficient to reach the impermeable layer of chalk rock. The later piles to be driven were therefore lengthened by 4.5 metres.

The bracings of the cofferdam were entirely of reinforced concrete held by steel sections welded to the sheeting. Little trouble was experienced with the cofferdam throughout the period of construction. To keep the working space dry 150 to 200 cubic metres of water were pumped out per hour.

It is intended, when financial arrangements permit, to construct the lock chamber, which will extend into the area of the old fish dock. The side walls will be formed of Larssen VI steel sheet piles with double courses of steel ties anchored to rear panels of steel sheet piles of lighter section. The superstructure of the walls will consist of a sturdy reinforced concrete capping beam faced with selected brickwork and a granite cope. The return walls of the inner gate abutments are to be constructed in a similar manner.

The bed of the lock chamber will not be lined; it is to be dredged only to cill level.

The inner lock gate will be of the more common V type, with two leaves of double skin welded steel operated by connecting rods and provided with the customary trimming compartments. The filling arrangements of the lock chamber consist of short culverts within the flank walls; they are provided with sluice valves accessible at low tide.

There will be a drawbridge over the gate at this point to replace the heavily used access road to the fish market, which used to run over the now demolished traverse between the old fish dock and the original Duquesne dock.

Until these works are completed the new Duquesne Fish Dock is being used as a floating dock with single entrance at high water only. M. Prempain, the engineer-in-chief of the Maritime Service (Section 2) of the Seine-Maritime directed the works, which were carried out locally by the engineer-in-Chief, M. Desbazielle.

Plans for New Shipbuilding Dock at Refshaleöen, Copenhagen

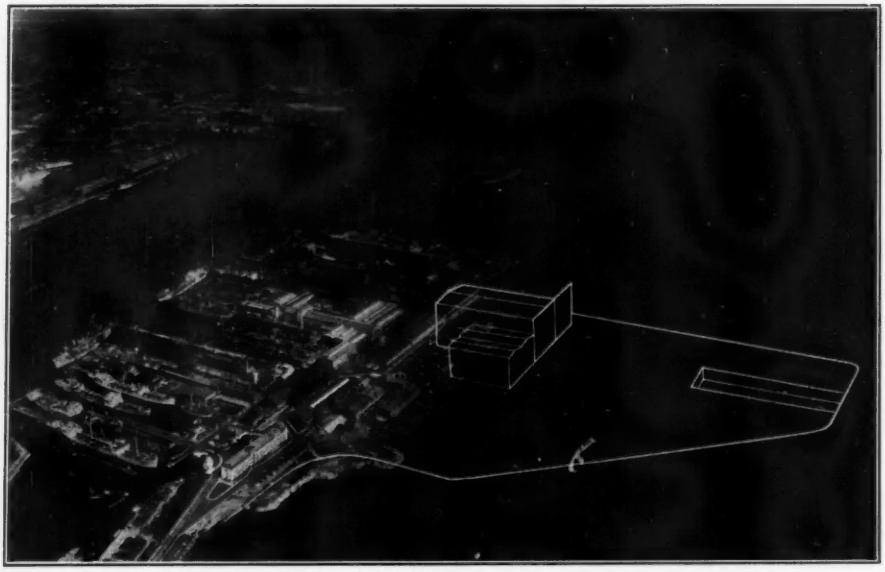
The new extension plans which have recently been announced by Messrs. Burmeister and Wain in Copenhagen will enable this firm to build ships of up to 60—70,000 tons deadweight. These plans form a further stage in a long process of modernisation which has been carried out at Refshaleöen since the Second World War. Previous improvements have included the building and adaption of new workshops and a new dry dock, which was first used in 1956. Considerable improvement has also been achieved in production conditions, particularly with regard to new building and repair work.

Hitherto these developments have prevented any major renovation of the slipways, although this improvement has been considered desirable for some time past, as the crane capacity and the dimensions of the existing slipways are no longer able to meet present day requirements.

When the new plans were being prepared, it was decided to construct a completely new building berth outside the existing yard in order not to interfere with the working of the yard as the old slipways are expected to be fully occupied for the next three years. The new berth will be achieved by filling in an area of about 300,000 square metres of the Sound to the east of Refshaleöen. By reclaiming this land, space will also be made available for the erection of workshops adjacent to the building dock. These will be of modern design and layout and will facilitate production methods which are a complete departure from those traditionally in use. One important improvement will be that a large part of the work will be carried out in covered workshops, with a consequent reduction in lost time during inclement weather and a considerable saving in production costs.

These advantages will be gained by constructing a special erection shop where large sections will be built for subsequent assembly in the ships in the new berth. There will also be a tenfold increase in the weight of the sections, as the new plant will be able to cope with sections weighing up to 400 tons in one crane load. As the traditional types of slipway cranes are inadequate for such heavy loads, it has been decided to instal gantry cranes which will span the building berth and run on rails on either side. The erection shop will be situated in line with the berth so that the same cranes can run into and also serve

Plans for New Shipbuilding Dock—continued



Aerial view of part of the Burmeister and Wain yard at Copenhagen. The white lines show the area to be reclaimed and the location of the erection shop and building berth.

that department. The height of the erection shop will be approximately 60 metres (197-ft.). Light cranes will also be provided on either side of the building berth.

Sub-sections for the large sections are to be assembled partly in the existing welding shops and partly in a new welding shop to be situated south of the main erection shop. The total workshop area will exceed 25,000 square metres.

Because of the advanced methods of construction employed, this berth when completed will have a capacity corresponding to at least two traditional building berths of the same size. Formally, slipways have generally been used for the building of ships, mainly because the initial cost of slipways is low. When building very large ships, however, the building berth has an economic advantage since the costs of launching are eliminated, and these increase considerably with the size of the ship. A further advantage is that building in a berth reduces the great stresses the ship is exposed to at launching; the lower and more horizontal position of the ship in the berth is also preferable for several other reasons.

The building berth on Refshaleöen will be approximately 240 metres (787-ft.) long, 38 metres (124-ft.) broad and with a depth of 9 metres (29-ft. 6-in.). If later found necessary, the berth could be extended and there will also be space available for a second building berth with attendant workshops to be constructed on the same piece of land should the need arise.

The new berth will be equipped with powerful pumping machinery, installations for pneumatic tools, welding cables, oxygen and acetylene plants, as well as a tank test pump with piping. Dredging will be carried out in the area adjacent to the berth with a view to employing this area as a repair berth when necessary.

Apprentice School

For a long time Messrs. Burmeister & Wain have considered building a school for their apprentices, where a more thorough and comprehensive education could be provided than in the yards alone. Owing to the increase in the labour force and the constant demand for special training for personnel, it has now been decided to put this project into effect. Until recently the apprentices at Refshaleöen were put to work in their particular departments immediately upon joining the firm but, when the school is ready which is expected to be some time during 1959, they will receive a six months' training course at the school before being sent to the workshops.

Initially, the school is intended for about one hundred apprentices of the various smiths' trades. It will be situated in pleasant surroundings outside the present yard grounds, and its workshops, equipped with modern tools, will be situated on the ground floor while the school room, lunch room, etc., will be on the first floor.

New British Standards for Cranes and Tractors

Industrial Crawlers and Tractors

Publication in 1951 of B.S. 1744 "Tests for Agricultural Tractors" gave rise to the need for a similar standard by means of which the performance and characteristics of industrial tractors could be determined and expressed. The new B.S. 2800; 1957, prepared under the supervision of the Road Engineering Industry Standards Committee, meets this need, and it is expected that it will be adopted as basic test procedure by the "heavy" tractor industry, as is the case with its well-tried counterpart, B.S. 1744.

Section One of B.S. 2800 deals with tests for engine performance, during which horsepower and specific fuel consumption are measured over the full range of engine speeds.

Section Two deals with drawbar performance tests, carried out with the aid of a drawbar dynamometer, during which measurements of drawbar horsepower, pull and specific fuel consumption are made over the whole range of drawbar pulls.

Section Three describes a static tilting test, by which it is possible to verify the claims of a manufacturer as to the suitability of his machine for operation on severe gradients.

Section Four specifies the procedure for final examination and the form in which the test reports shall be drawn up.

Power Driven Jib Cranes

As with the seven existing British Standards for cranes and excavators, the purpose of a revised publication (B.S 357: 1958) is to indicate minimum construction requirements and to ensure reliability and safety in use. It places no restrictions on the general design of cranes or on the methods employed in their construction.

The standard deals with travelling jib cranes (power-driven, rail-wheel-mounted, on low carriage) of the following types:—

Non-shunting, free on rail; shunting, free on rail; portable type; any of the above type using outriggers; any of the above types, but with part slewing.

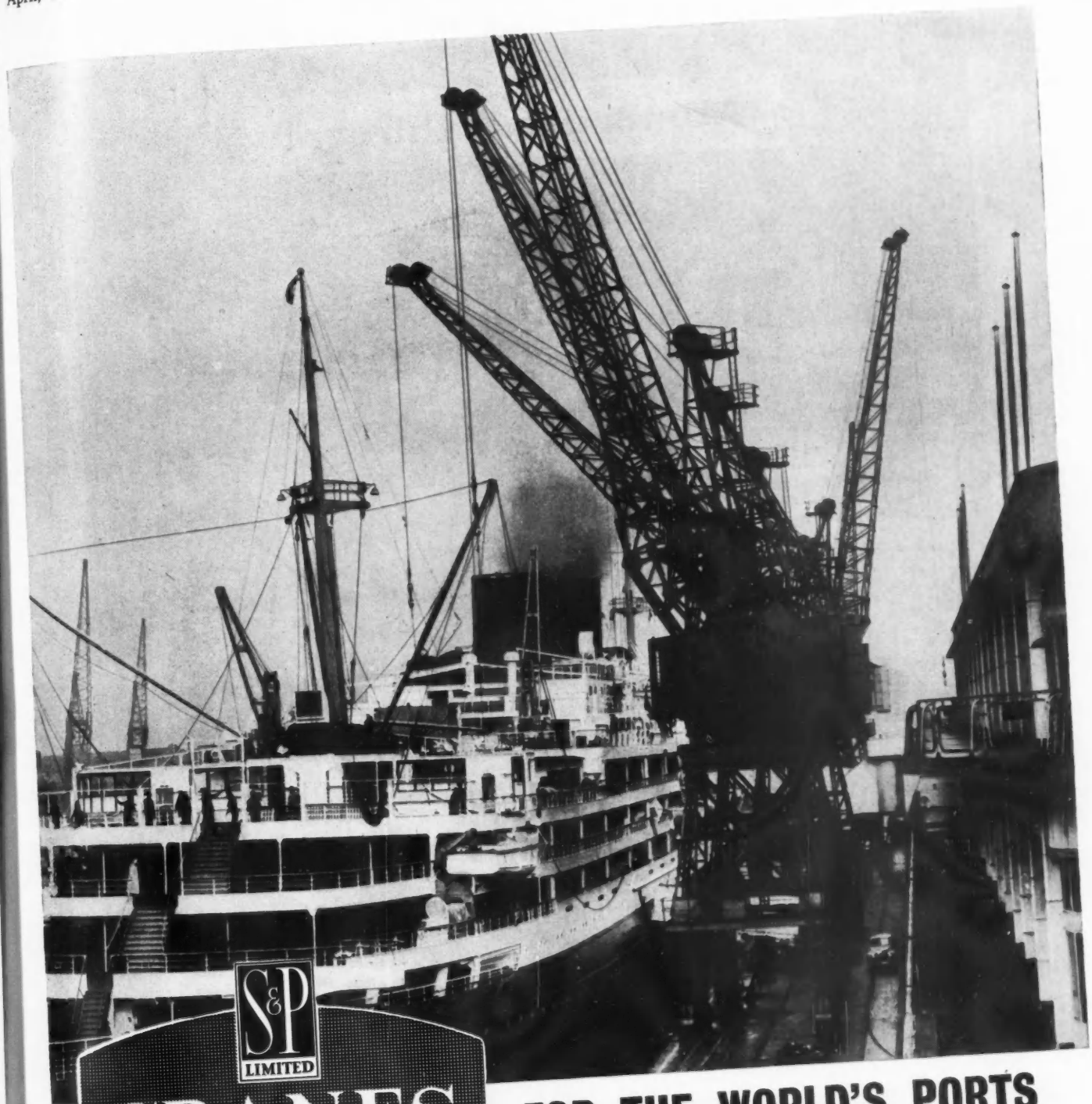
"Safety in operation" is given special emphasis and there are clauses which specify requirements for guarding, brake-magnets, electrical protective gear and limit switches.

The method of calculating forces in steel members in the crane structure now refers to the recommendations contained in B.S. 2573 "Report on Permissible Stresses in Crane Structure," and the principle of using a factor of safety has been discarded. The original method was based on the ultimate tensile strength of the material, but now the elastic limit is the criterion.

Detailed requirements are specified for the design of the crane structure and hoisting equipment, and for brakes, electric motors, controllers and protective gear. The clause on stability has been modified and there is now only one set of coefficients. Test requirements are tabulated for easy reference.

The appendices include a full list of British Standards for materials and equipment suitable for use in manufacture, information regarding load capacity of gears, and definitions of crane speeds.

Copies of both these Standards may be obtained from the British Standards Institution, 2 Park Street, London, W.1. Price 5/- and 10/- respectively.



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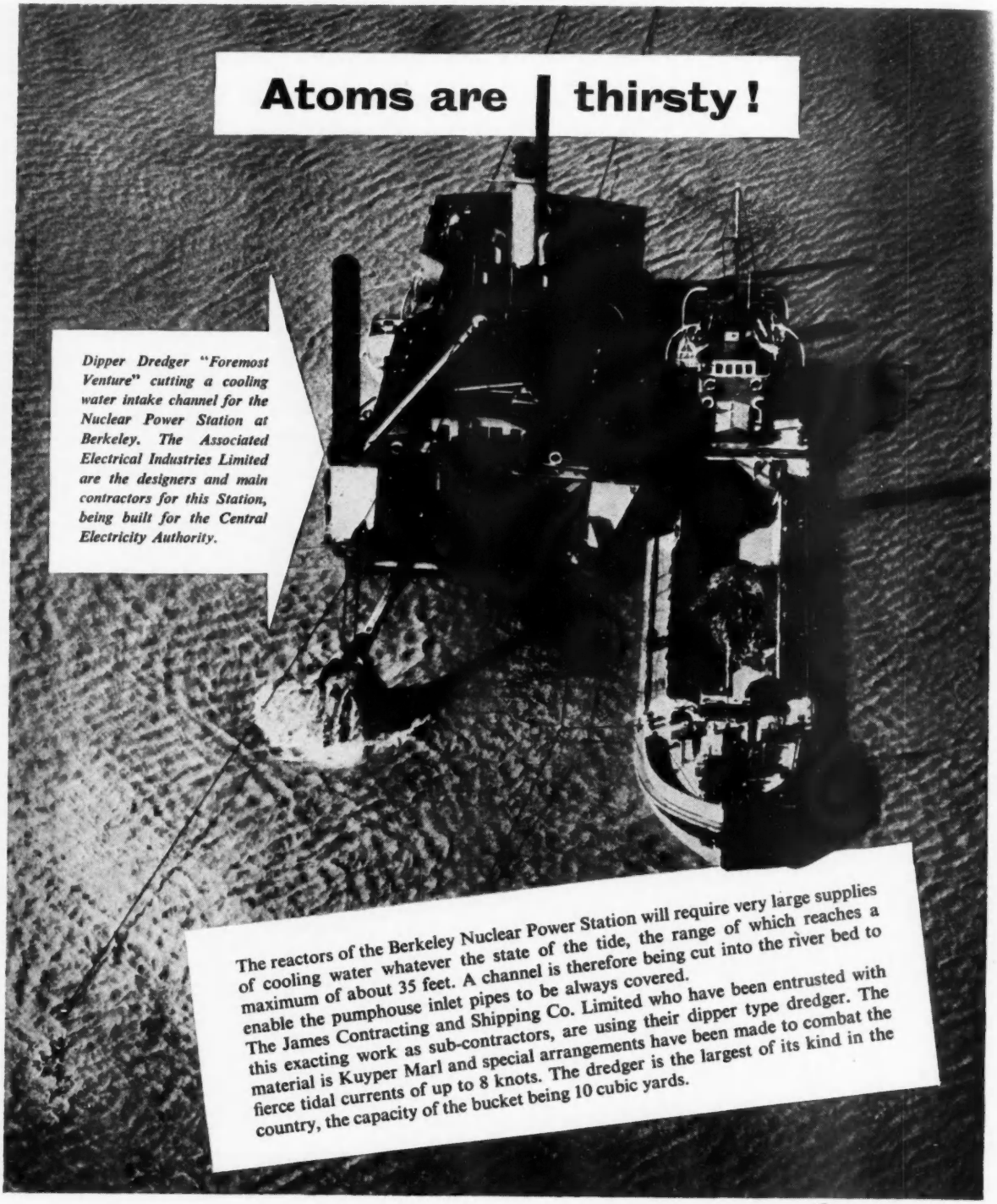

Dipper Dredger "Foremost Venture" cutting a cooling water intake channel for the Nuclear Power Station at Berkeley. The Associated Electrical Industries Limited are the designers and main contractors for this Station, being built for the Central Electricity Authority.

The reactors of the Berkeley Nuclear Power Station will require very large supplies of cooling water whatever the state of the tide, the range of which reaches a maximum of about 35 feet. A channel is therefore being cut into the river bed to enable the pumphouse inlet pipes to be always covered.
The James Contracting and Shipping Co. Limited who have been entrusted with this exacting work as sub-contractors, are using their dipper type dredger. The material is Kuyper Marl and special arrangements have been made to combat the fierce tidal currents of up to 8 knots. The dredger is the largest of its kind in the country, the capacity of the bucket being 10 cubic yards.

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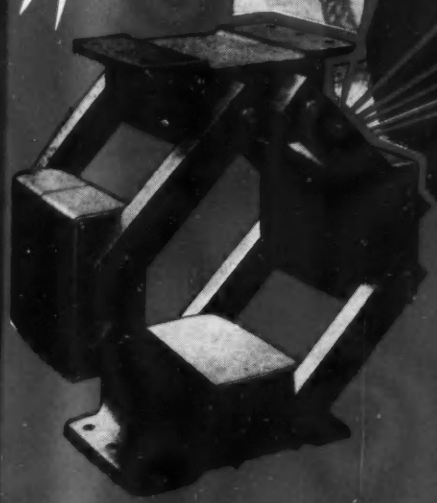

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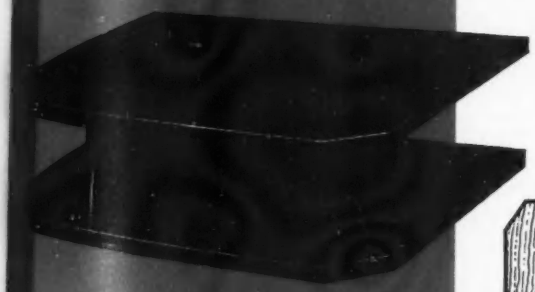
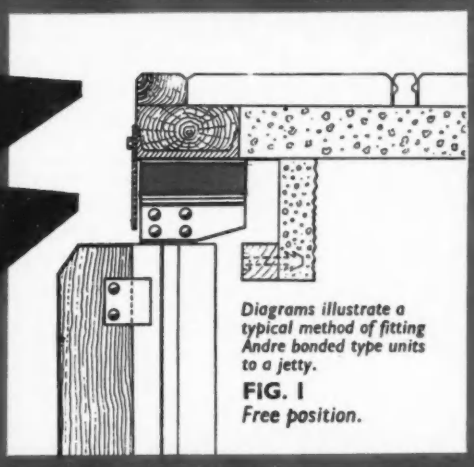
Below is shown an alternative Fender Pile Unit of the bonded type.



Bonded Type Unit.



Diagrams illustrate a typical method of fitting Andre bonded type units to a jetty.

FIG. 1
Free position.

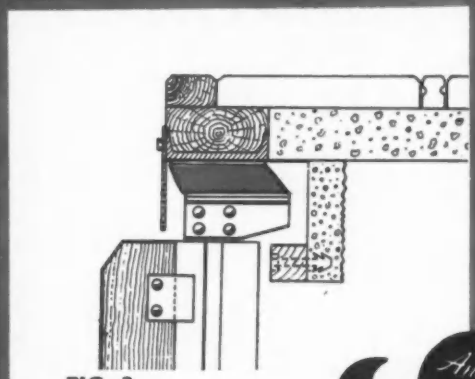


FIG. 2
Under load.

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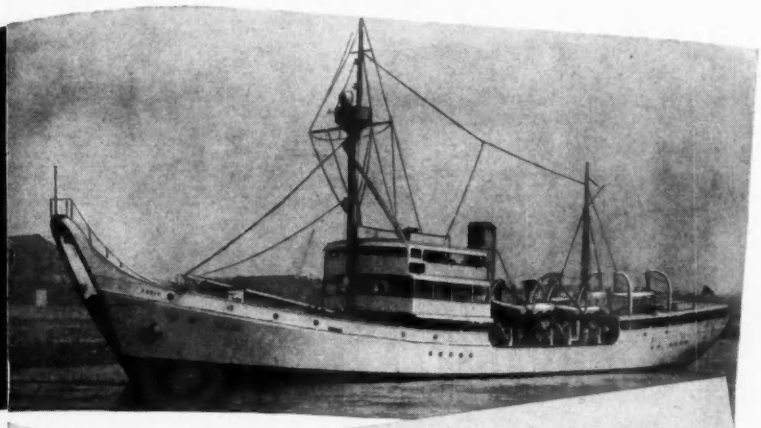

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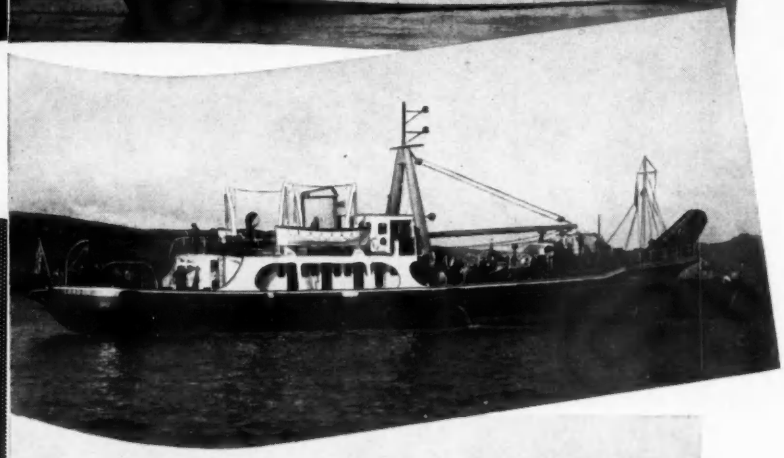

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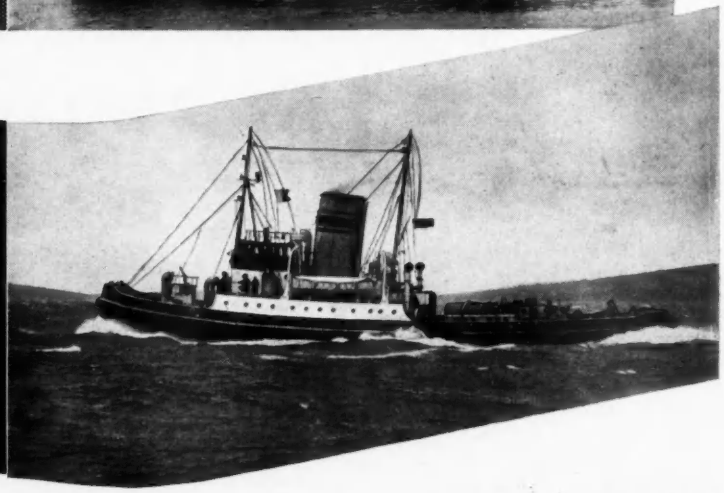

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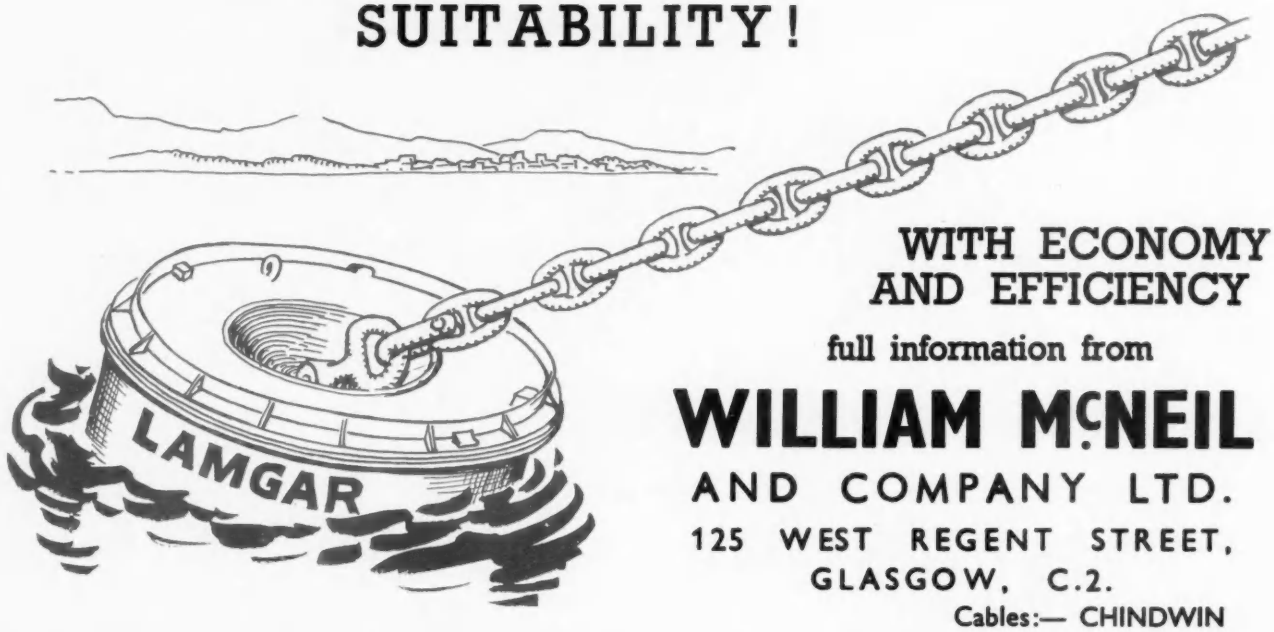

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One of a number of 204 B.H.P. diesel locomotives working at the Port of Bristol incorporating 8.L3 Gardner Engine, Scoop Control Fluid Coupling and S.S.S. Powerflow Gearbox. Weight in working order 39 tons.

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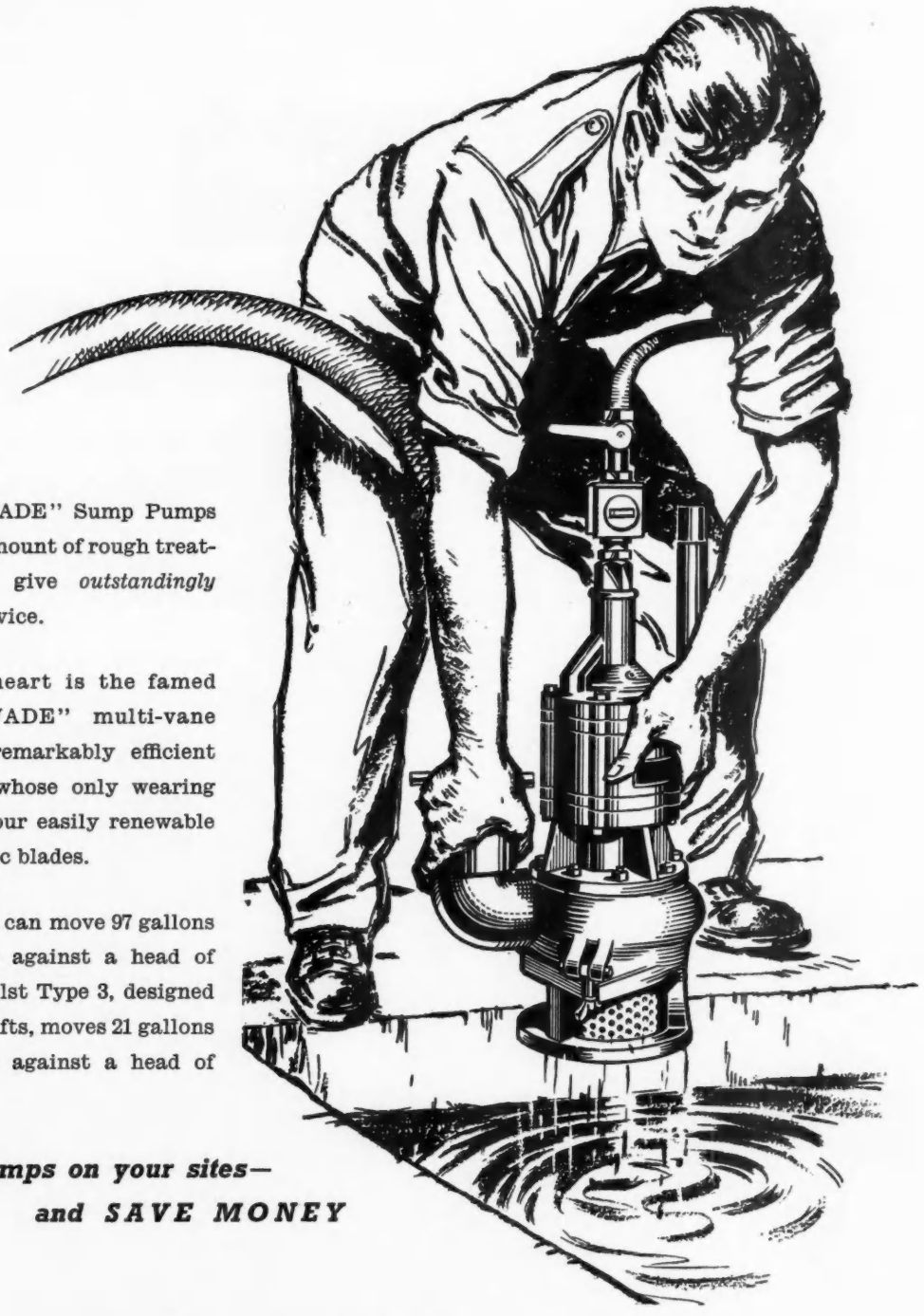

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Ship to Shore handling...

The S.S. "Carl Schmedeman" is a new type of ore-carrying ship with its own built-in materials handling plant. The illustration shows just one of the many different kinds of conveyor that Fraser & Chalmers make, both for ships and shore.

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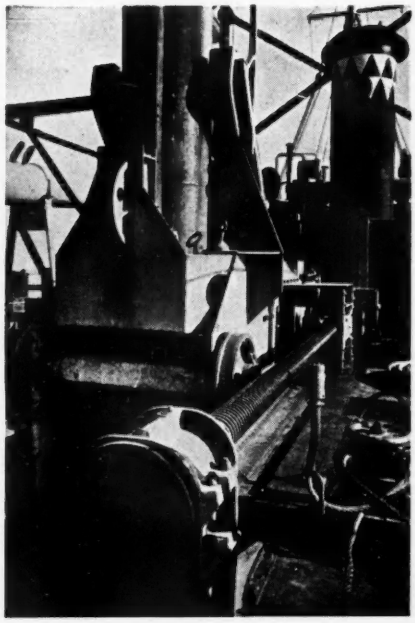
NUMBER SEVENTEEN

I.H.C. HOLLAND NEWS ITEMS

A BI-MONTHLY BULLETIN ON DEVELOPMENTS IN DREDGING

THE SPUD CARRIAGE SYSTEM

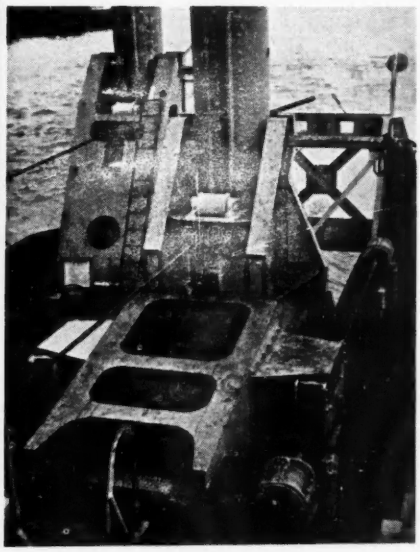


I.H.C. Holland has a spud system which is of special advantage when a cutter suction dredger is required to advance rapidly, that is to say when only a shallow cut has to be made, as for example in maintenance dredging, and crossing of the cuts would mean loss of production.

This installation comprises two spuds of which the working spud is fitted in a carriage travelling in a well in the after part of the dredger, whilst the other is an auxiliary spud mounted in a guiding device on the pontoon and serves only for temporary anchorage. A spud carriage may travel distances up to 20 ft. and is operated by screwed shafts which are driven by a separate motor on the after deck.

The system operates as follows: — The spud carriage is moved to the forward end of the well and the working spud lowered; as dredging proceeds the carriage is moved aft by means of the screwed shafts through a distance equal to the desired advance of the dredger per cut. This operation is repeated until the carriage has reached the after limit of its travel. Then the auxiliary spud is lowered to hold the vessel in position while the working spud is raised and the spud carriage moved to the forward end of the well, when the operation is ready to be repeated by lowering the working spud and raising the auxiliary spud.

The special advantage of this is that spoil is removed along concentric arcs, thus



ruling out the possibility of the cuts crossing each other. Furthermore the manoeuvre of advancing to the next cut takes considerably less time than with the normal arrangement of two spuds, fixed to the pontoon, resulting in a higher hourly output of the dredger.

Depending on circumstances, such as angle of swing and number of cuts before advancing, this increase in output may vary from 20 to 60 per cent.

DID YOU KNOW?

The Third Series of I.H.C. Holland Technical Bulletins is now well under way. Two issues — one dealing with a fleet of dredgers delivered to Pakistan and one describing four craft built for Calcutta — are already available. Others are expected shortly; their publication will be announced in "Ports and Dredging".

*

For Vizagapatnam, India, I.H.C. Holland is now building a steam dipper dredger of advanced design.

*

A 32-page booklet describing the activities of the I.H.C. Holland laboratories, the Mineral Technological Institute, at Delft, is now being printed. This booklet sets out some of the problems connected with dredgers on which the laboratory is working, how they are being approached, and indicates some results.

*

The twenty-second dredger built for Pakistan by I.H.C. Holland is working in the port of Chittagong.

*

Many craft built by I.H.C. Holland have propulsive and other machinery made in I.H.C.'s own engineering works. Their programme includes Smit-M.A.N. and Smit-Bolnes diesels, Foster-Wheeler and scotch boilers, Brouwer and other modern steam engines.

*

I.H.C. Holland has delivered to Dutch Guyana a large cutter suction dredger for use in the bauxite fields which are being exploited by the Aluminium Corporation of America, Pittsburgh Pa..

*

In eleven post-war years I.H.C. Holland yards have booked nearly four hundred orders on capital units, mostly dredgers, of which about seventy five percent was destined for foreign countries.

D.4

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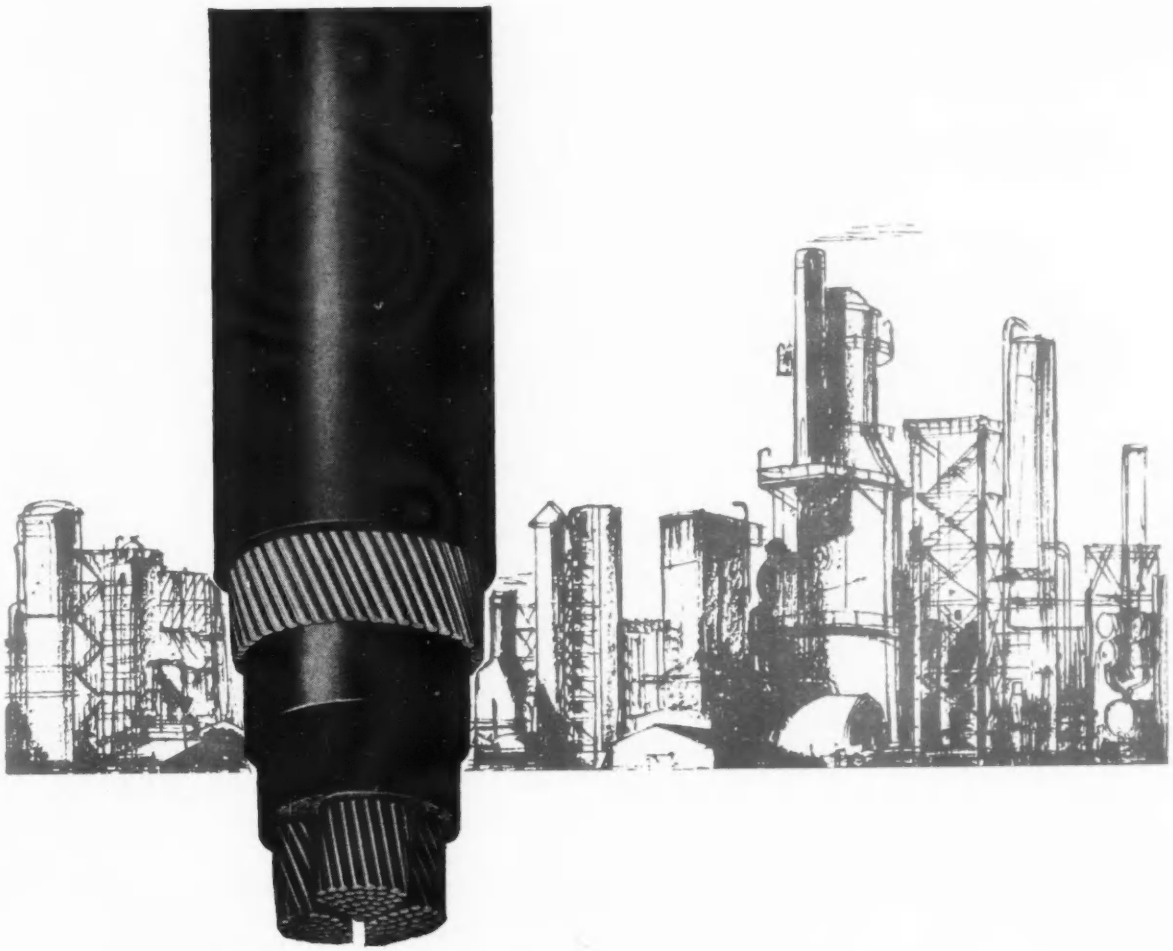

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Our brochure "Coal-shipping plant on the Tyne" contains a full description of this plant. Why not write for it today ?

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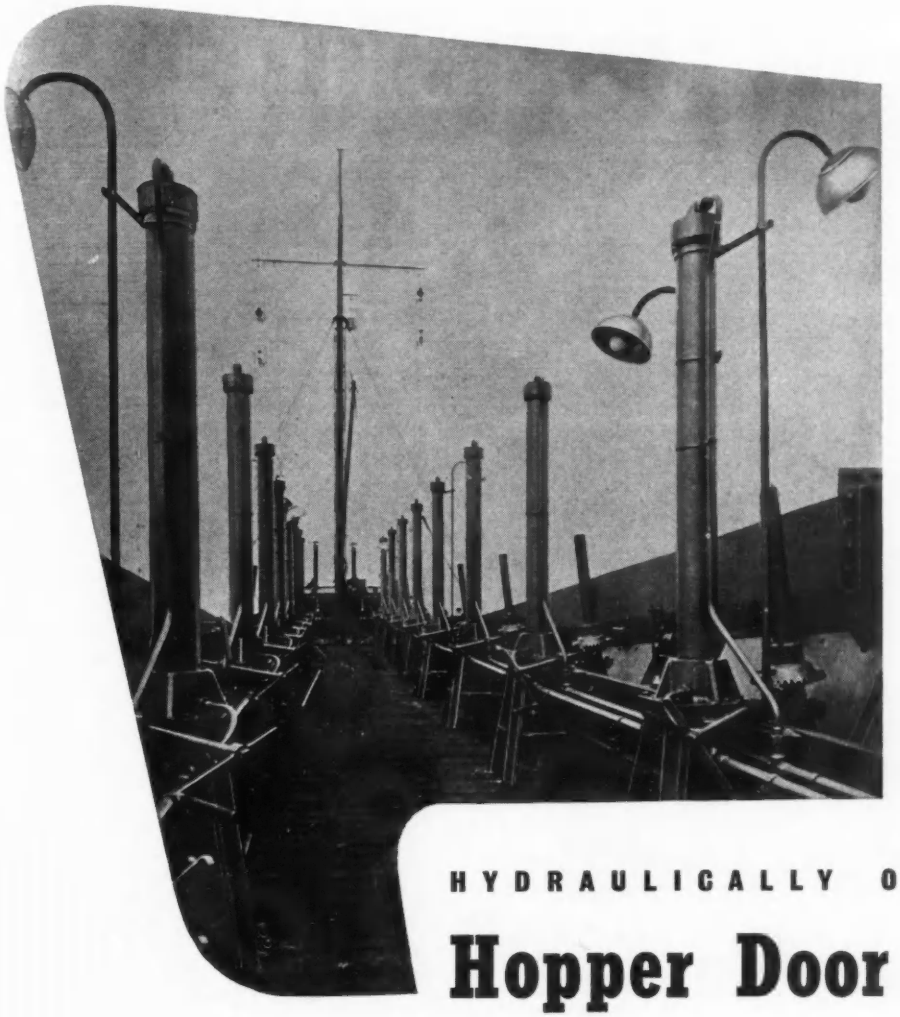

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Hopper Door Rams

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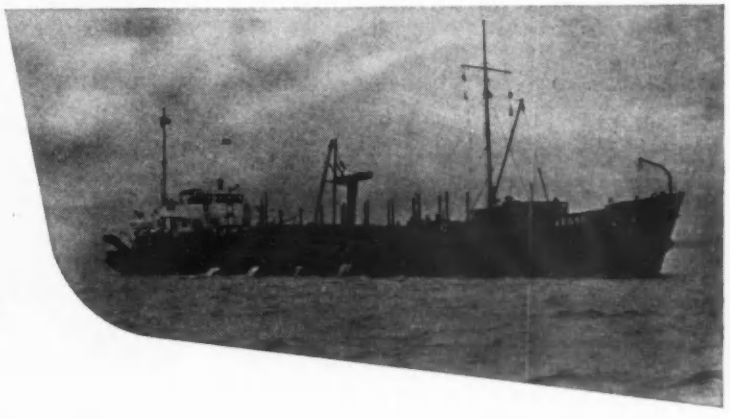

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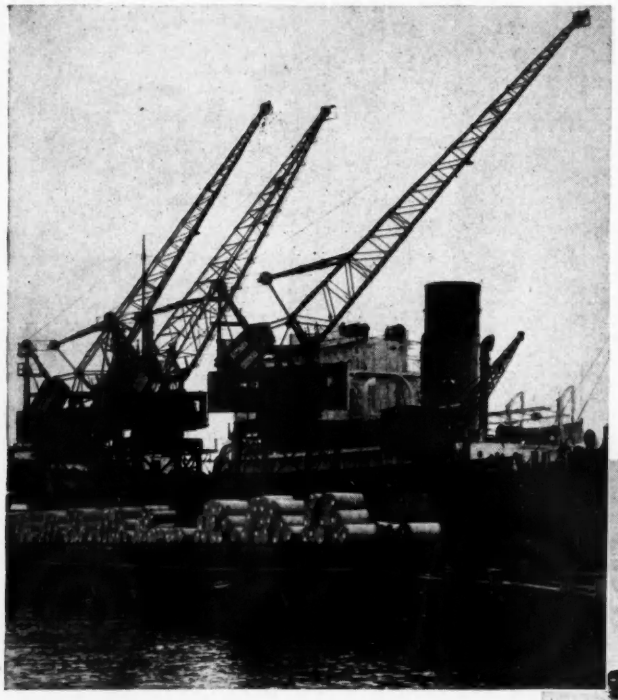

In the World's great ports Smith Level-Luffing Cranes are standard equipment for cargo handling—for the very good reason that Smiths have been building cranes for more than 100 years and have unrivalled knowledge and experience of this work.

Illustrated are two examples of Smith Level-Luffing Crane installations. The upper photograph shows part of a battery of Smiths at Purfleet on the River Thames; the lower one is of an installation at Basra, in Iraq.

Smiths of Rodley are also known the World over as manufacturers of Diesel Cranes, Diesel Locomotive Cranes, Lorry-mounted Cranes, Mobile Cranes and a wide range of Universal Excavators —all built to uniformly high standards of reliability, economy and efficiency.

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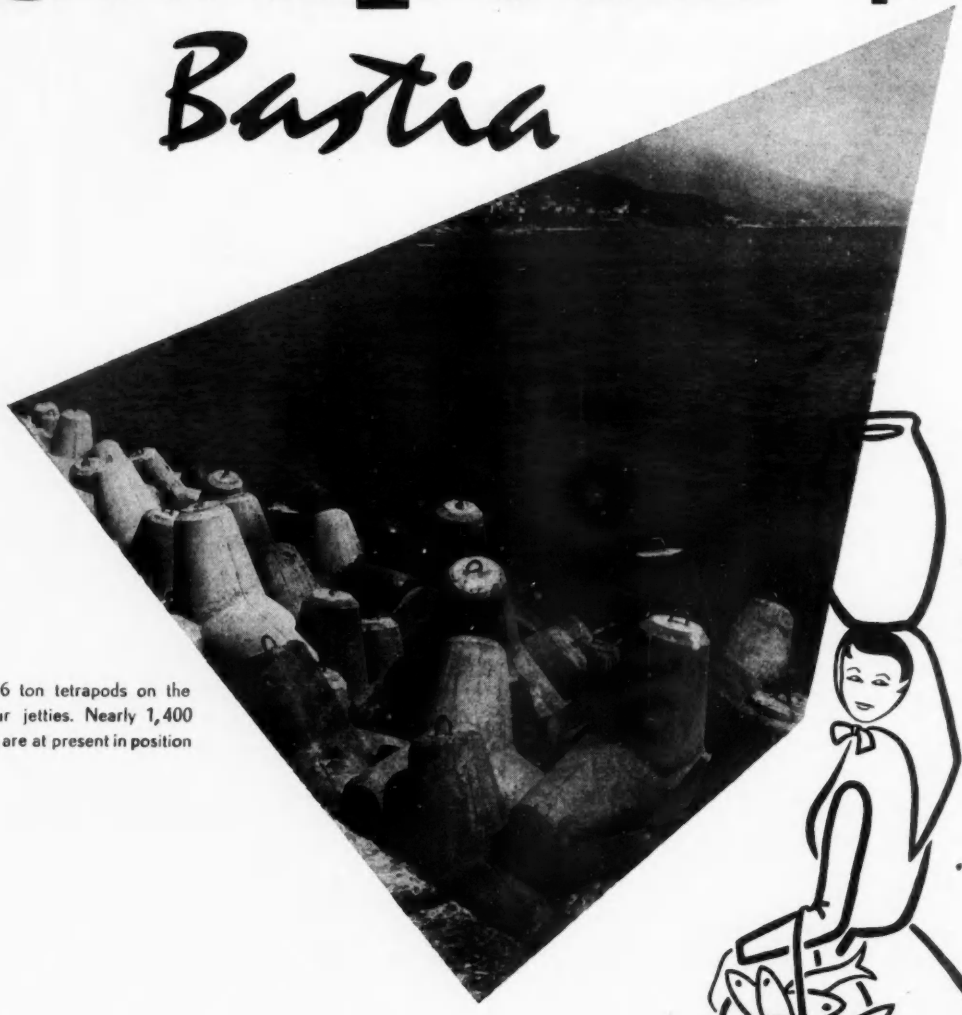

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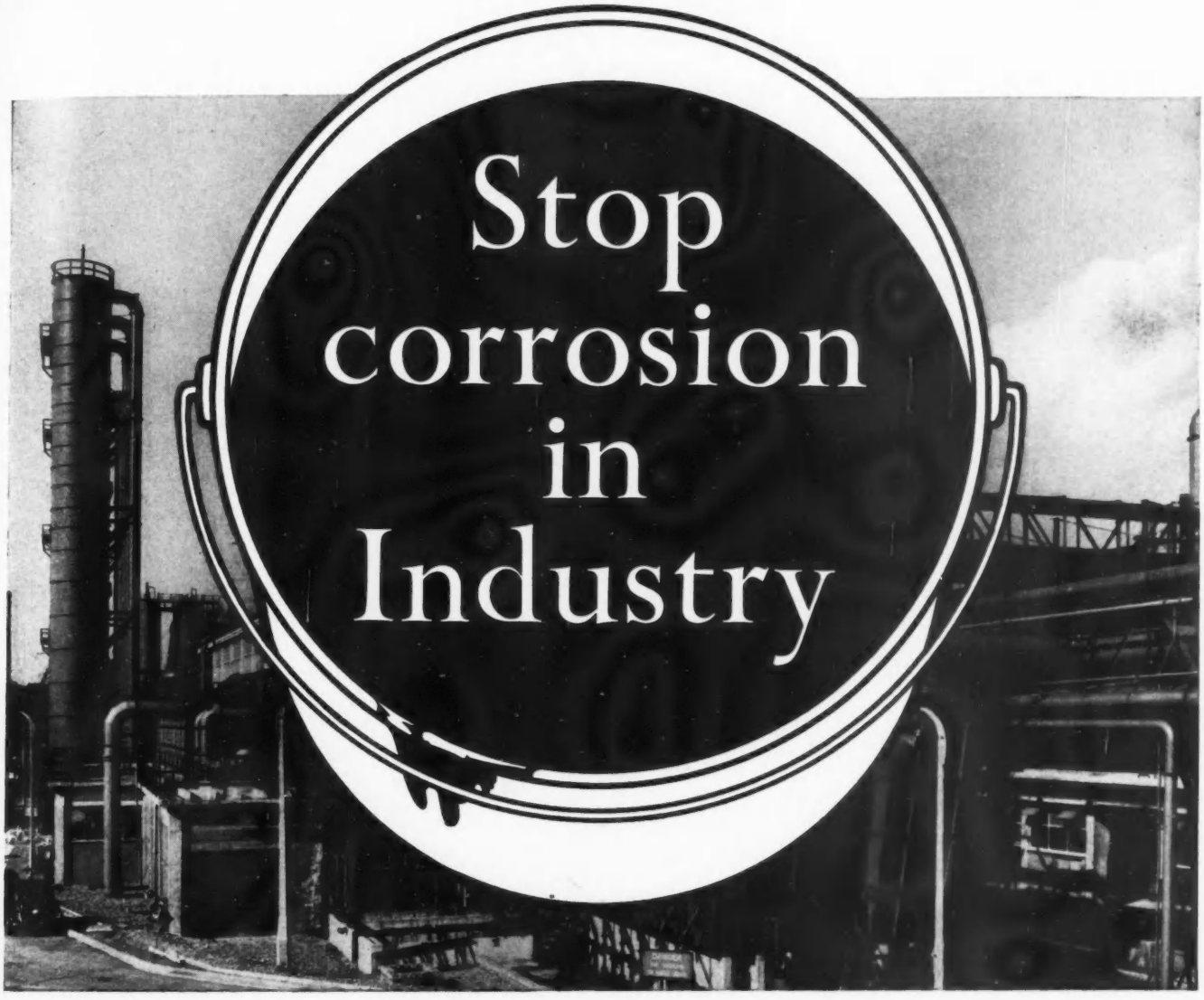

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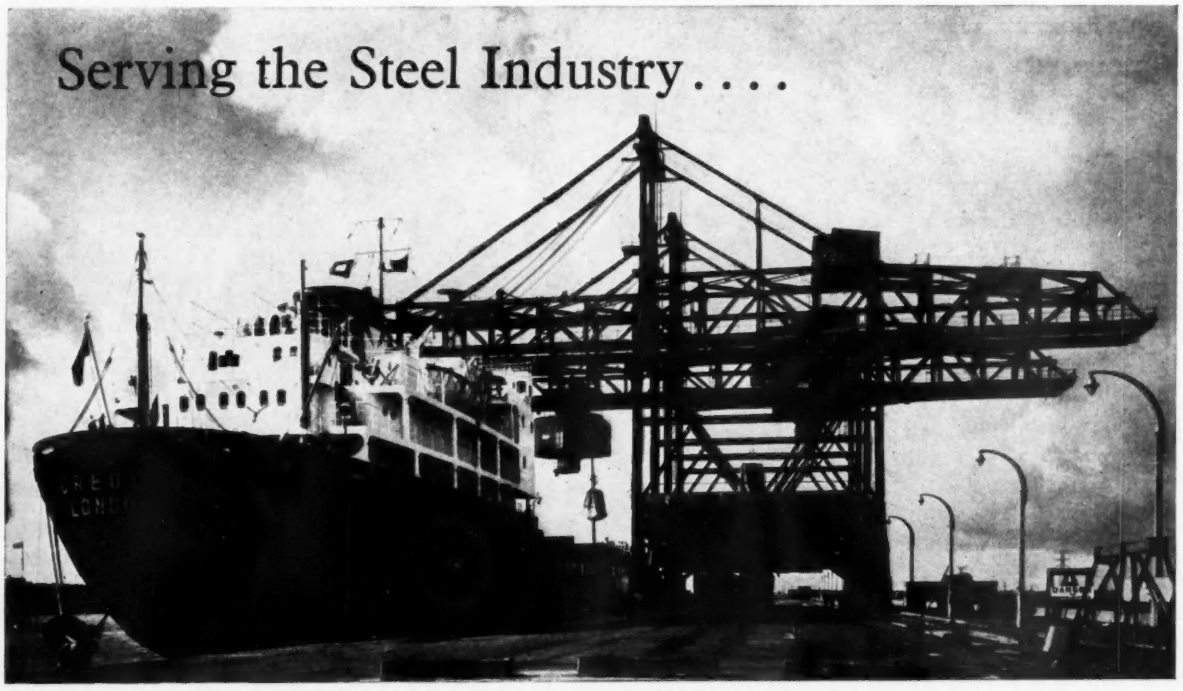

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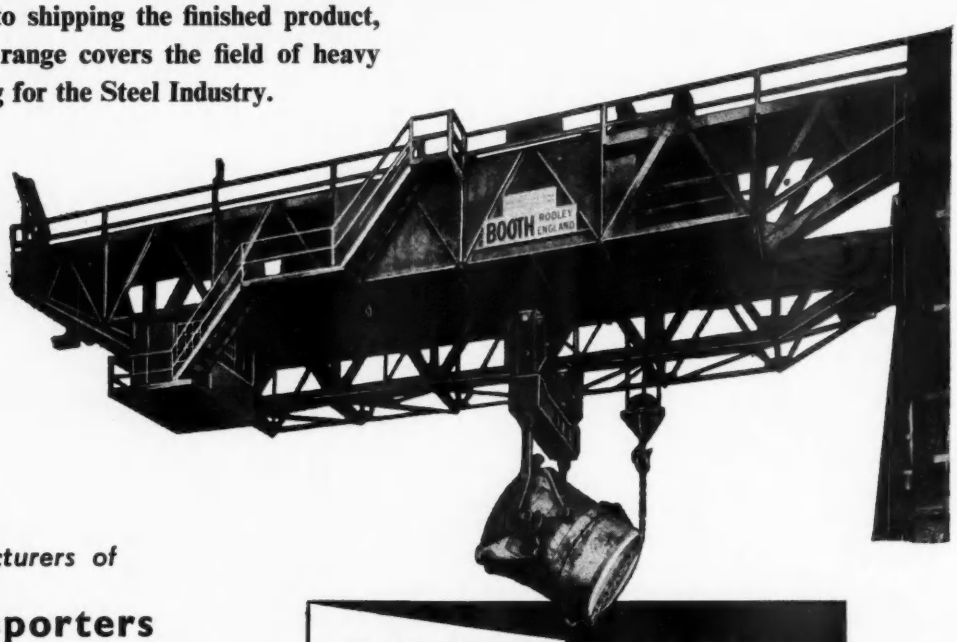

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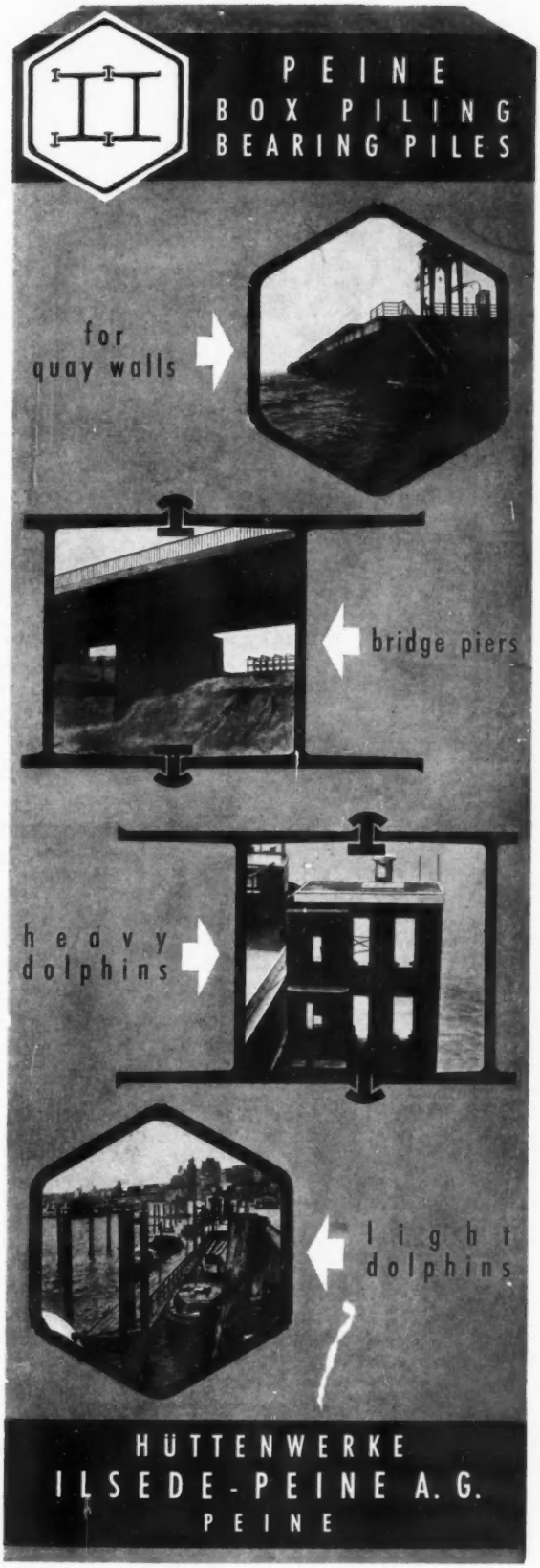

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The 112-ft. diesel tug "ATHERFIELD," illustrated here, and her sister ship "CULVER" were built at our Woolston works for Red Funnel Steamers Ltd. primarily for handling tankers at Fawley, Southampton; they incorporate extensive fire - fighting apparatus. Many Dock and Harbour Authorities both in this country and overseas operate tugs built by Thornycrofts.

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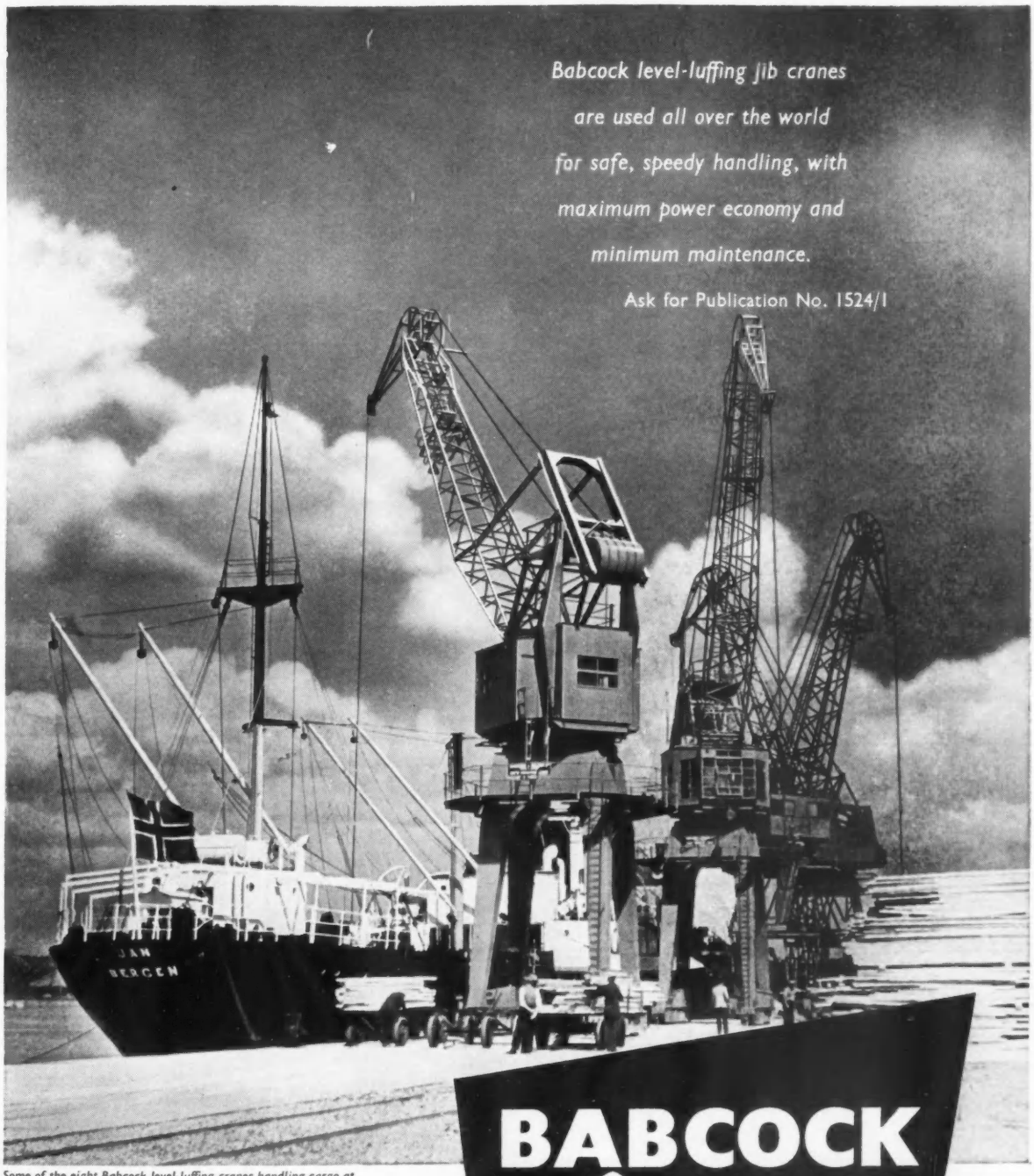

Some of the eight Babcock level-luffing cranes handling cargo at Cliff Quay (Ipswich Dock Commission)
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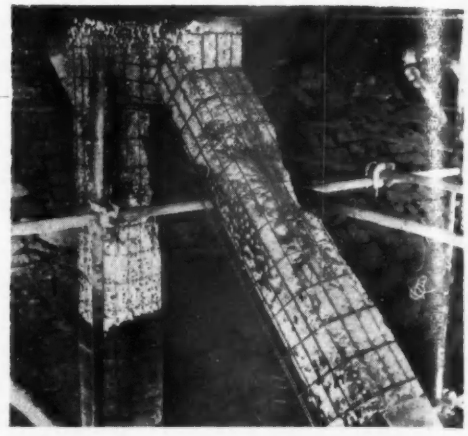

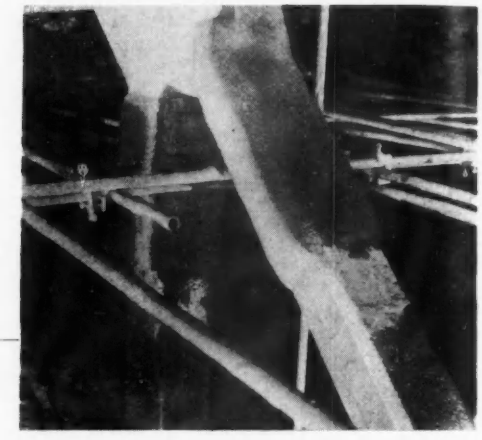

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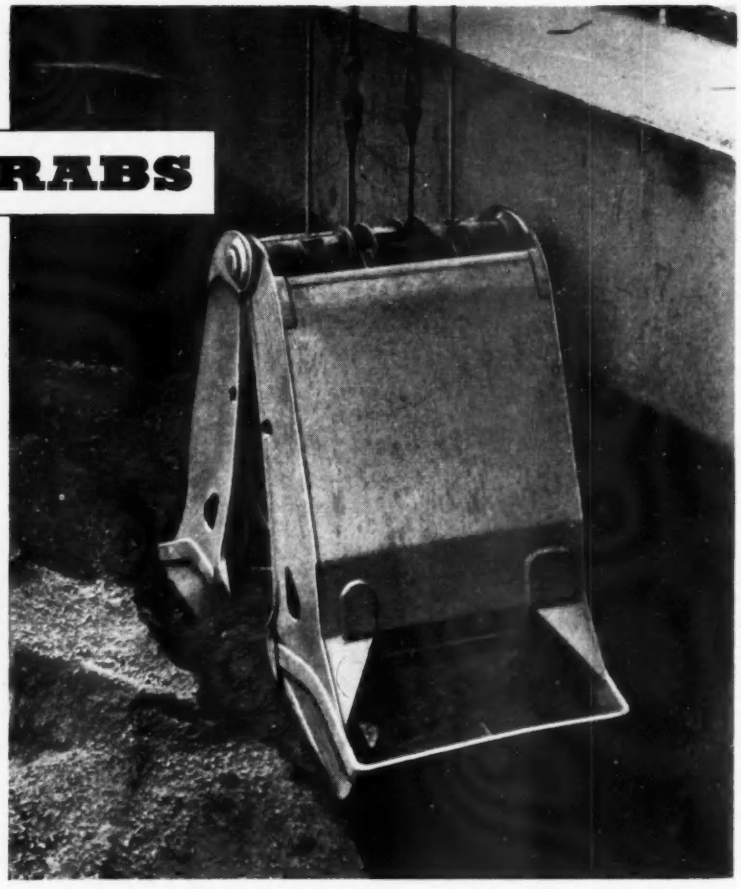
Made by the people who put the noun 'Grab' into the English Dictionary



From the Priestman range of nearly 3000 grabs. Illustration shows Trojan Grab unloading cargo from ship's hold.

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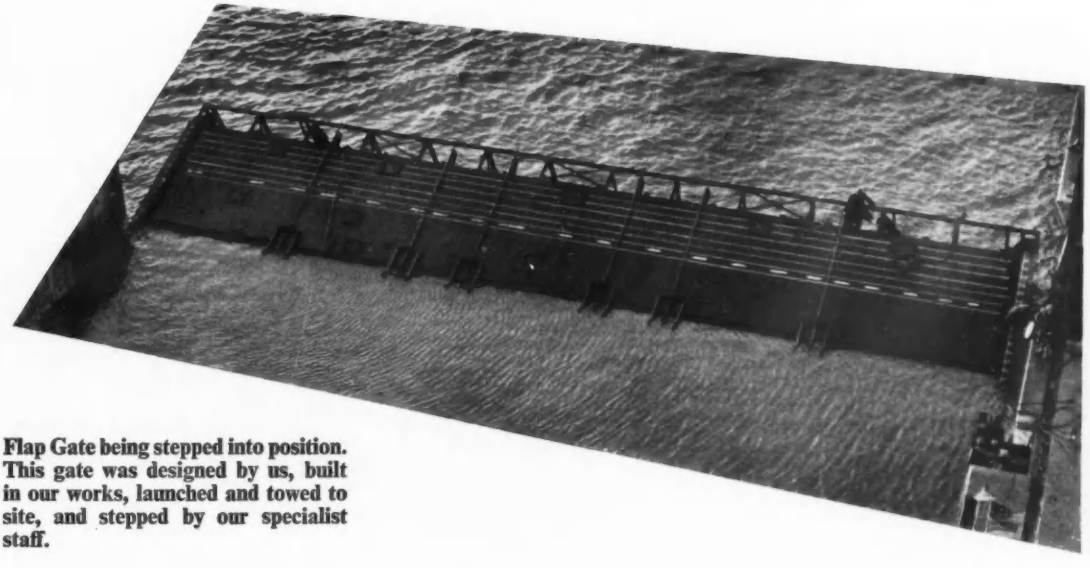
Flap Gate for Messrs. Brigham & Cowan Ltd's new dry dock at South Shields being floated into position prior to stepping.

flap gate for a new dry dock



Flap Gate being stepped into position. This gate was designed by us, built in our works, launched and towed to site, and stepped by our specialist staff.

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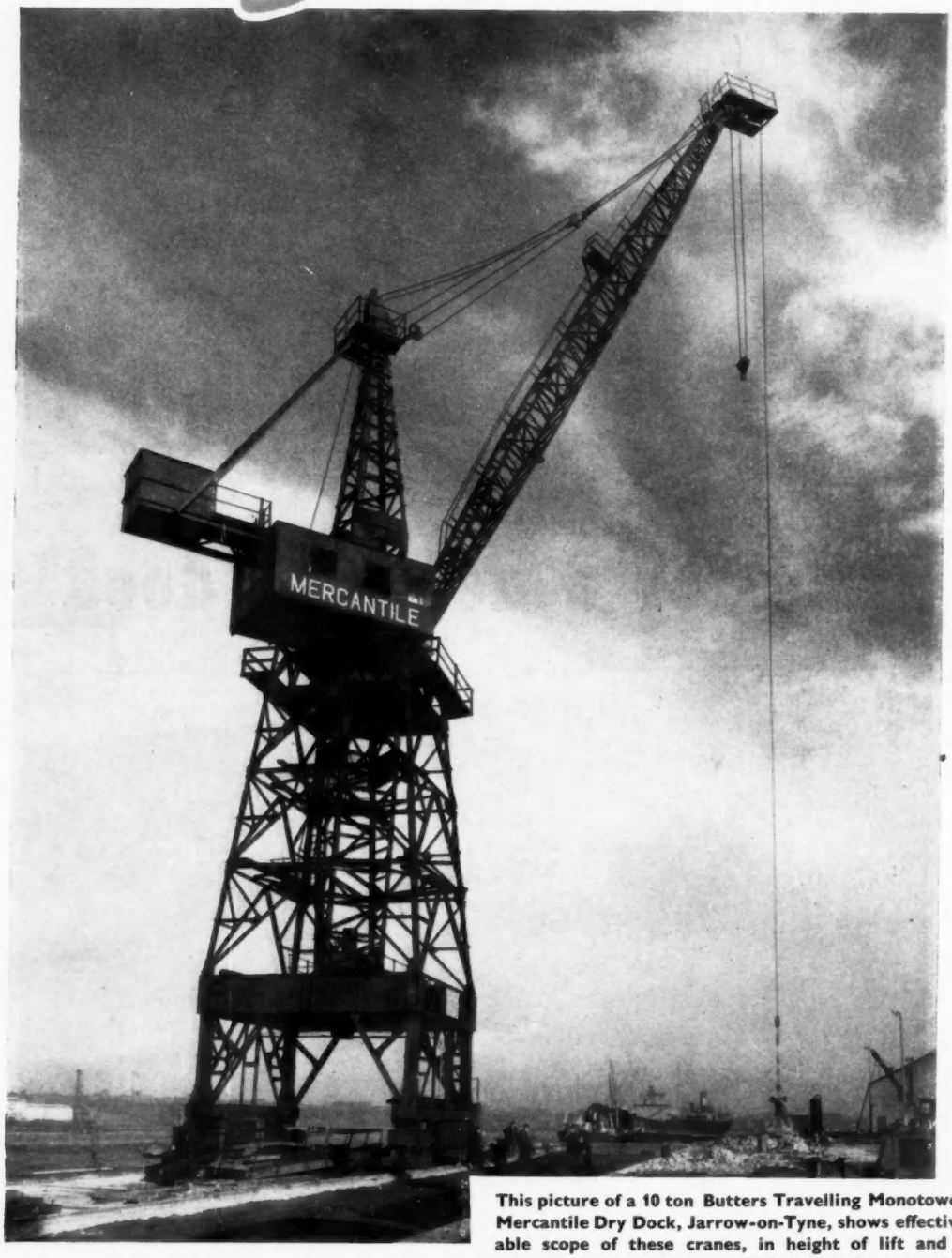
A RECENT *Butters Monotower*



This picture of a 10 ton Butters Travelling Monotower erected at the Mercantile Dry Dock, Jarrow-on-Tyne, shows effectively the remarkable scope of these cranes, in height of lift and radius, and the freedom from obstruction. This particular crane handles 10 tons at 90 ft. and 4 tons at 125 ft. radius.

Photograph by courtesy of
MESSRS. MERCANTILE DRY DOCK CO. LTD.
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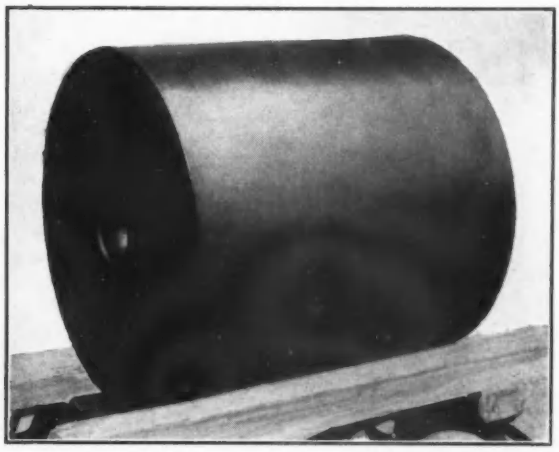
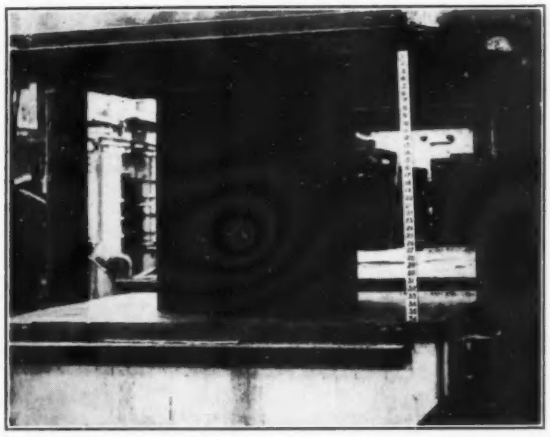
During the last few years, having developed the technique of vulcanising large masses of rubber, Leyland has been able to manufacture rubber fender blocks up to 6 feet long by 4 feet diameter having adequate energy capacity to absorb the berthing forces of the largest ships afloat.

The proper use of rubber for this purpose arises from joint consultation between Leyland and the Civil Engineers concerned with the design of any particular scheme, and as no two schemes are alike, the size, shape and energy capacity of the blocks involved must be precisely suited to the overall design of jetty.



32 inch diameter by 32 inch long fender block for Little Aden jetties.



Fender block ready for compression test.

Recently commissioned British Petroleum Company jetties using Leyland blocks designed in collaboration with the engineers of British Petroleum Company and Messrs. Rendell, Palmer & Tritton of Victoria Street, London, include :

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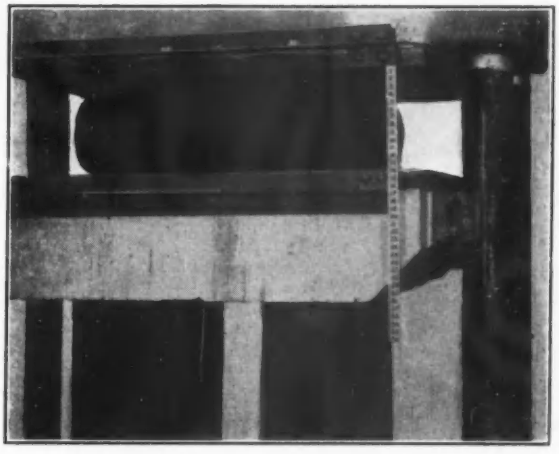

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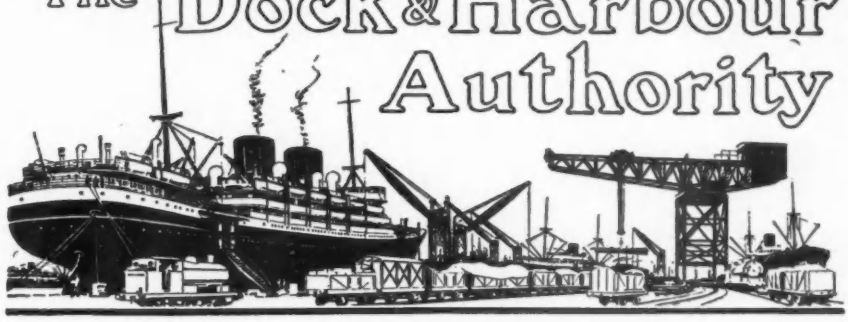

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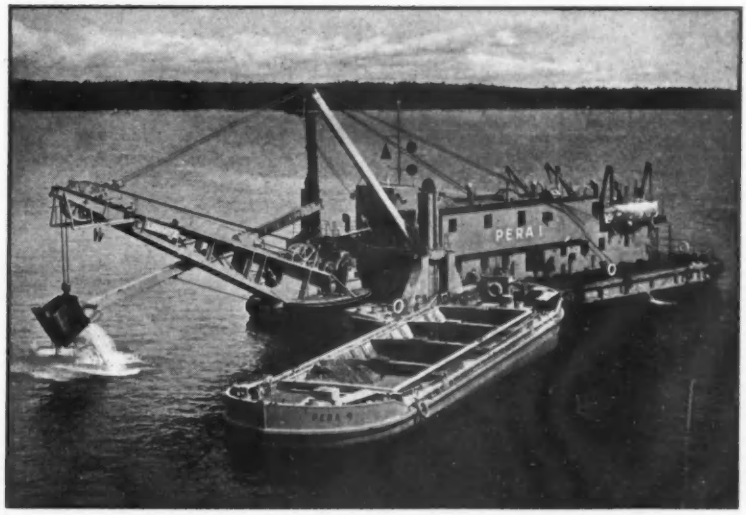
Keeping things clear in Finland....



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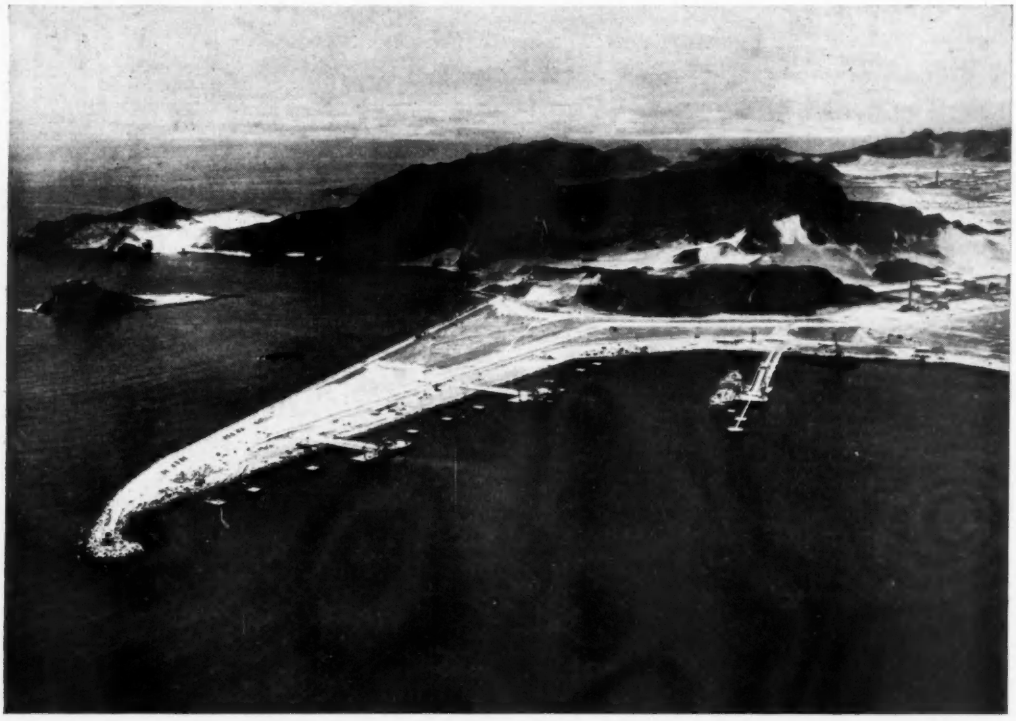

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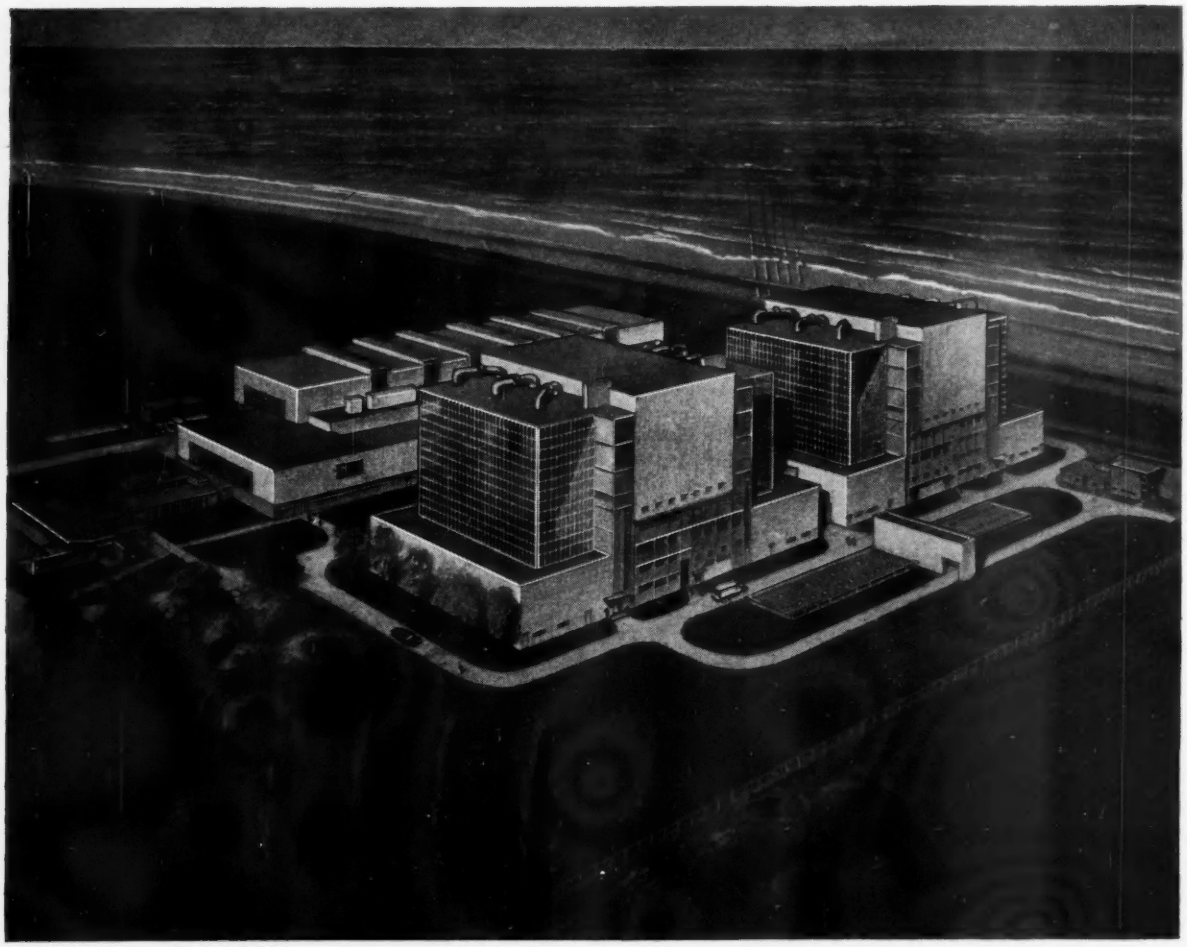

Bradwell Nuclear Power Station

This illustration is an artist's impression of the Bradwell Nuclear Power Station, which is to supply electricity to the National Grid. All hydrographic survey work in connection with this project was carried out by Kelvin Hughes on behalf of the Consulting Engineers: Messrs. Rendel, Palmer & Tritton, acting for the Central Electricity Authority.

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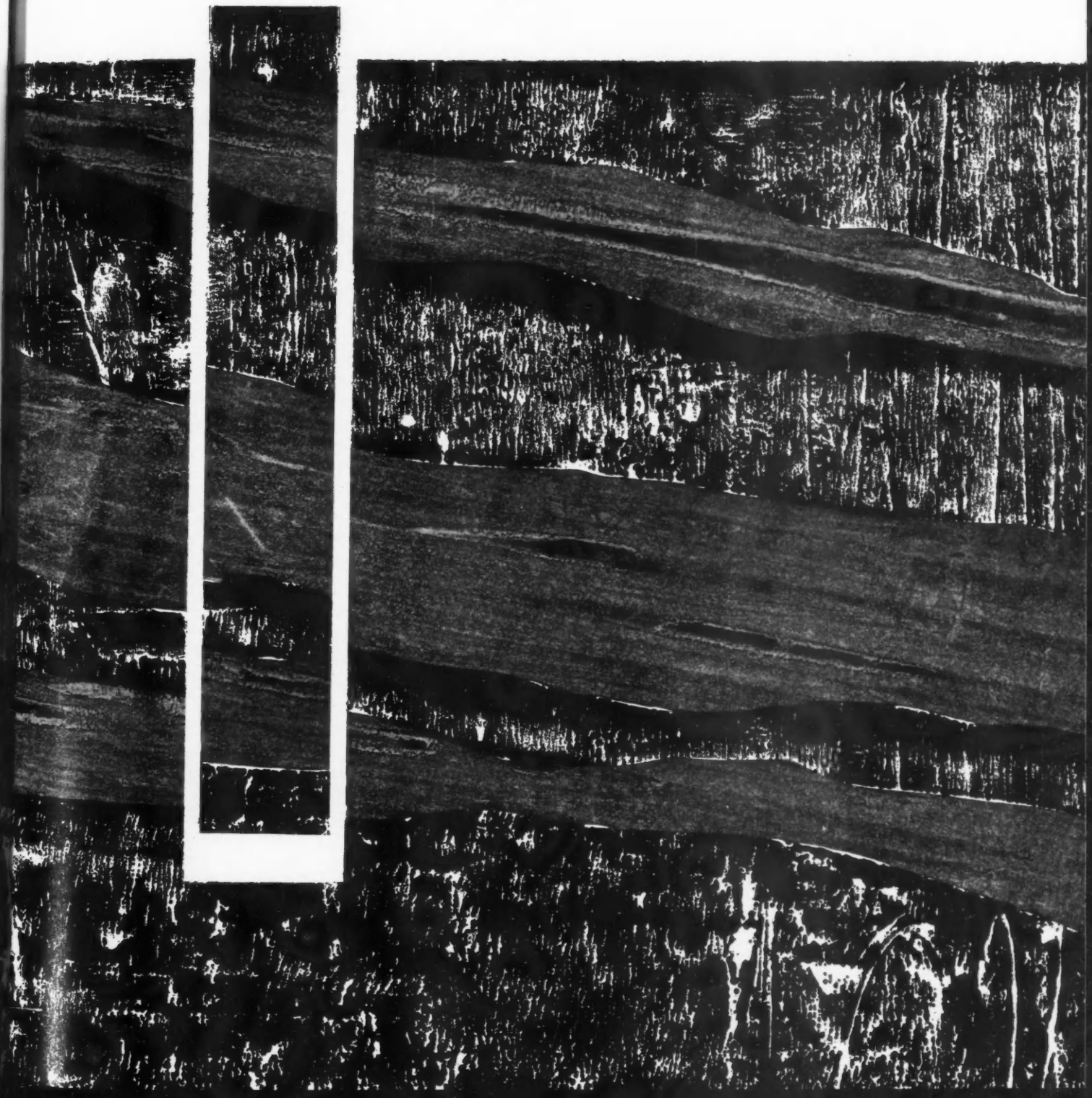

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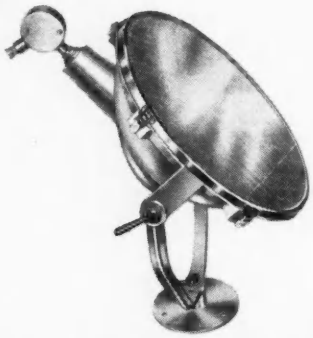

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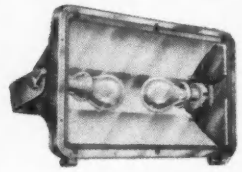

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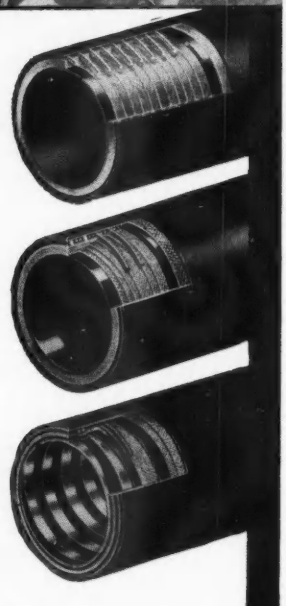

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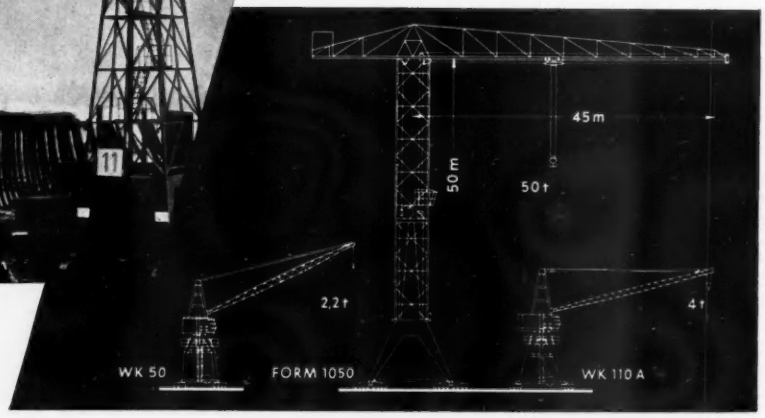

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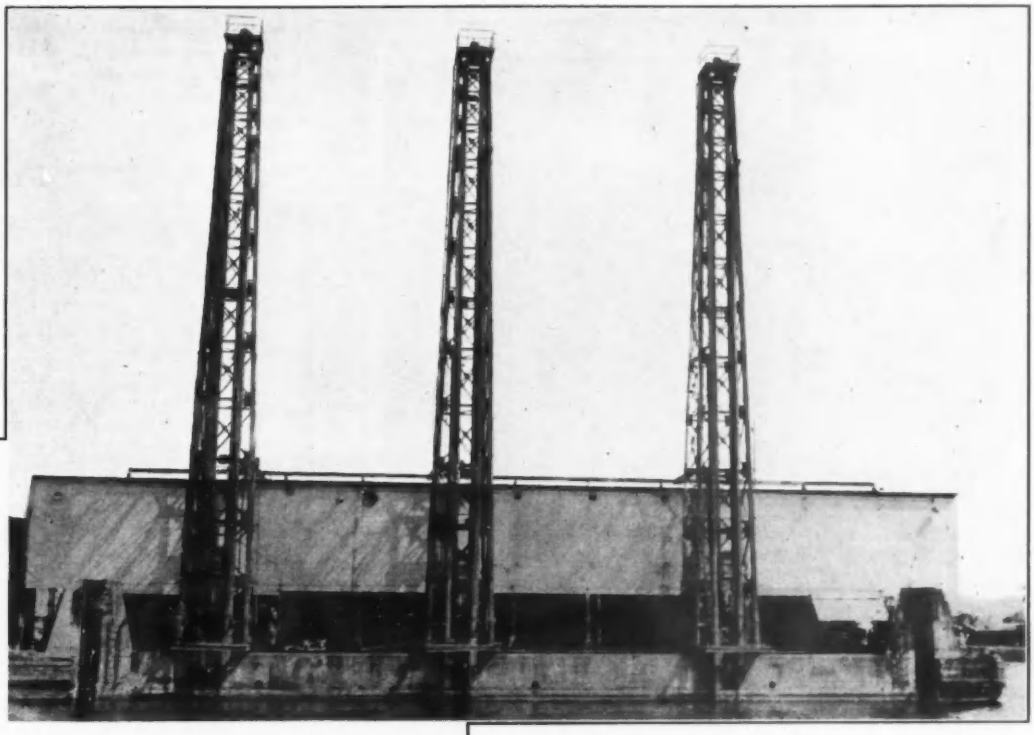

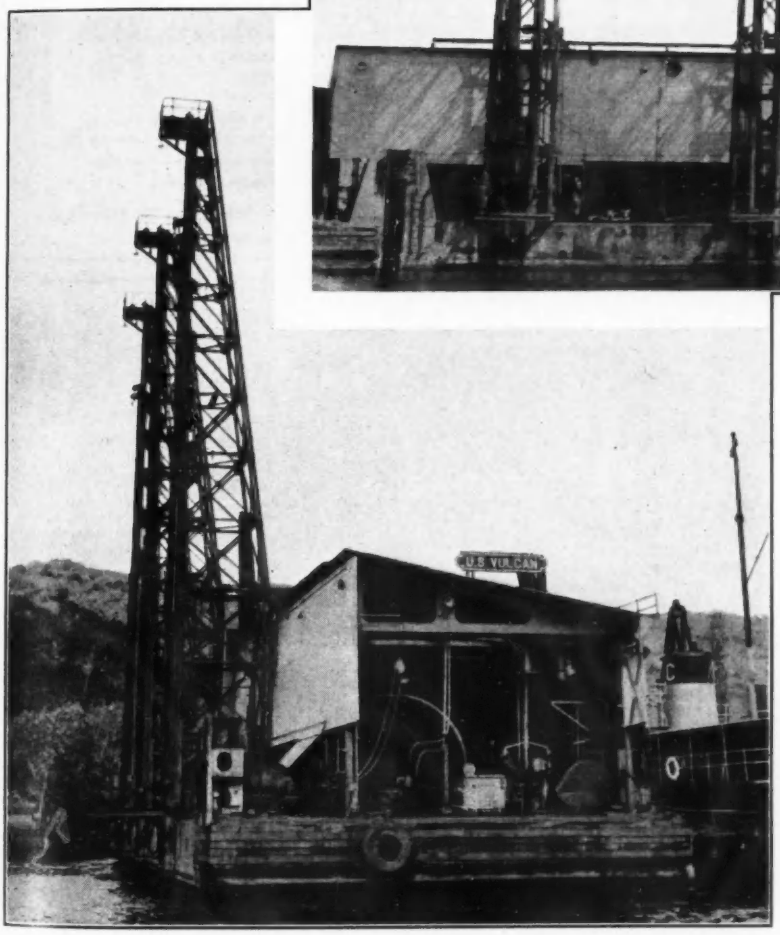

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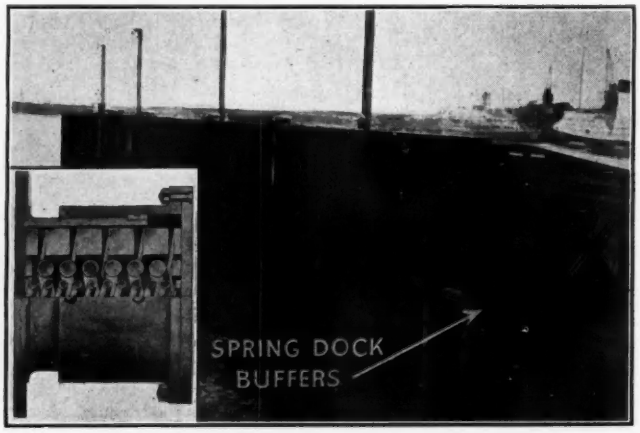

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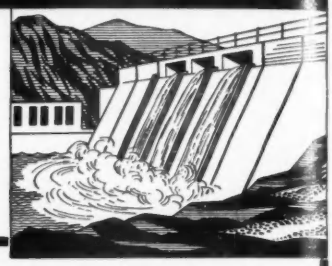

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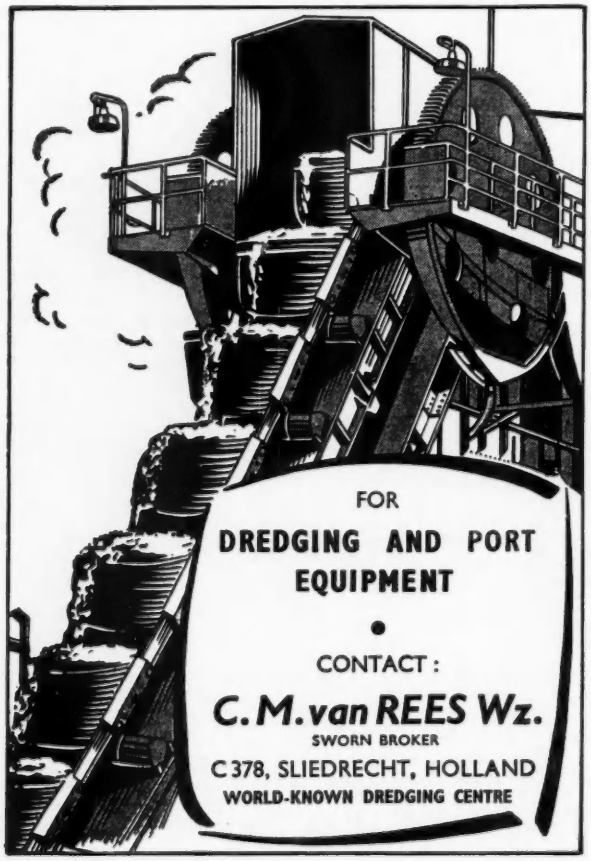

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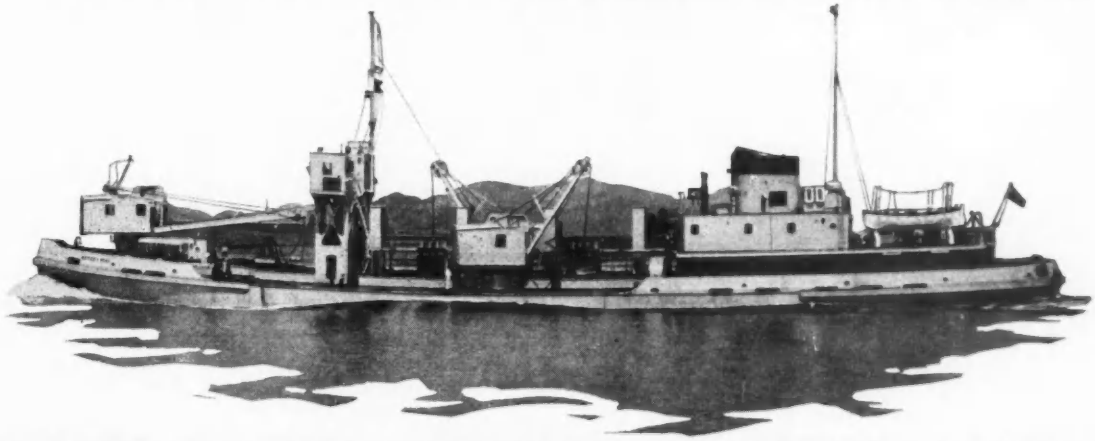

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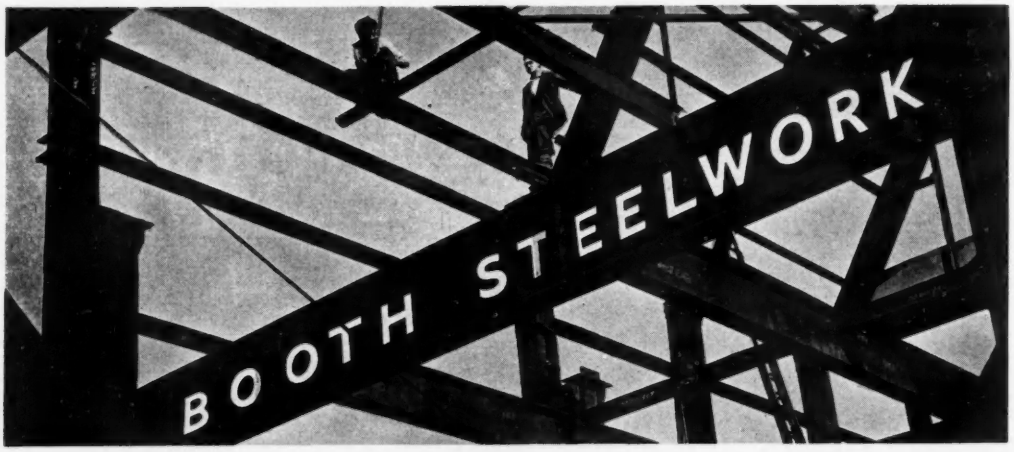

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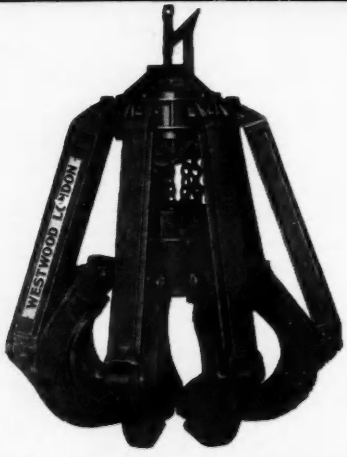

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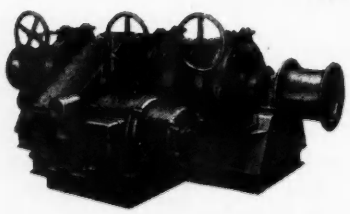

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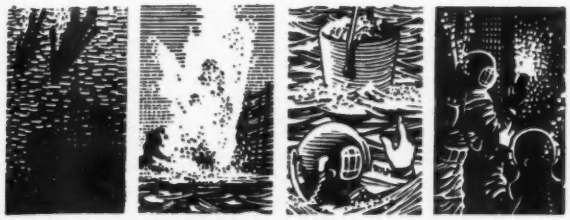

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[*Continued overleaf*

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Photograph by courtesy of National Coal Board

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Photograph by courtesy of National Coal Board

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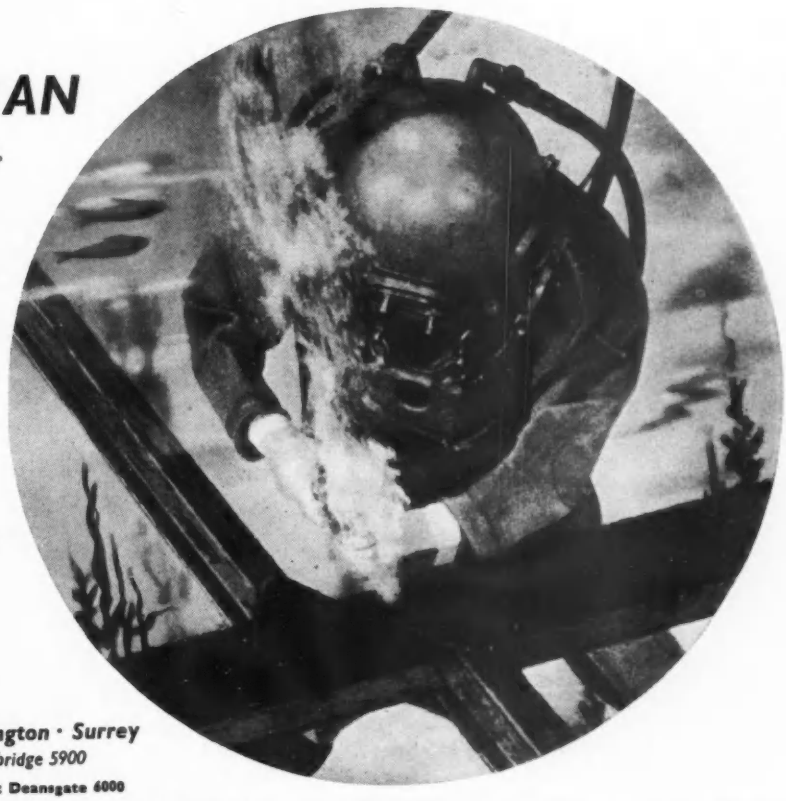

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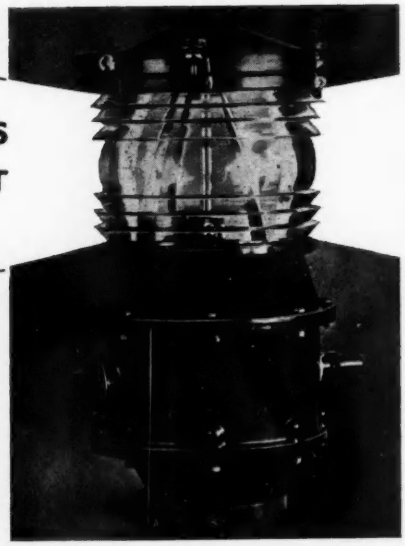

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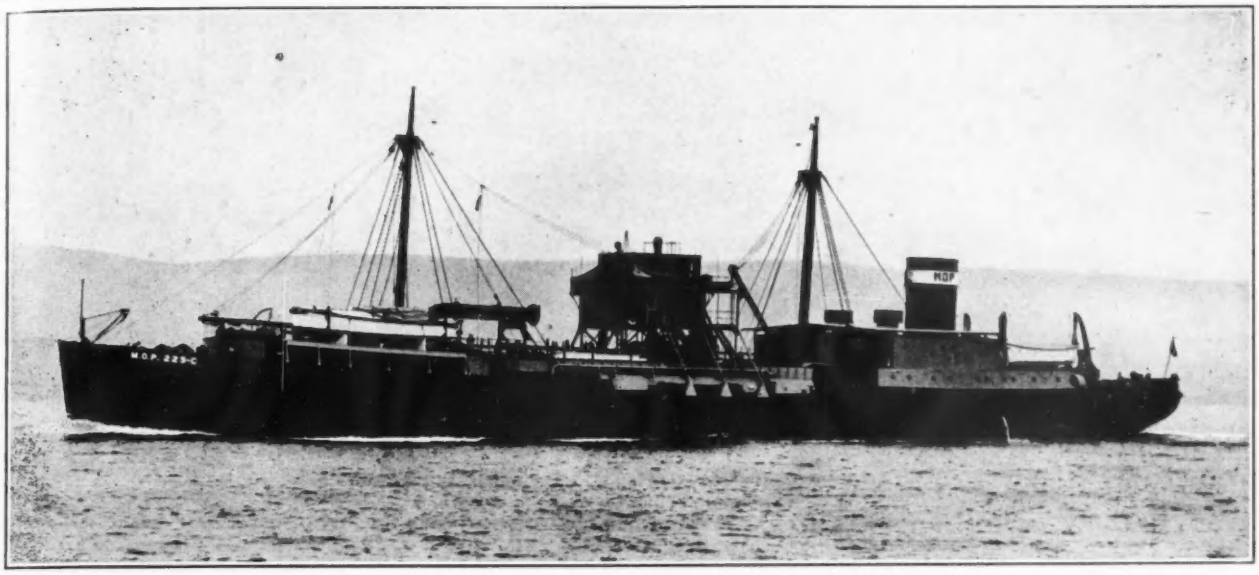

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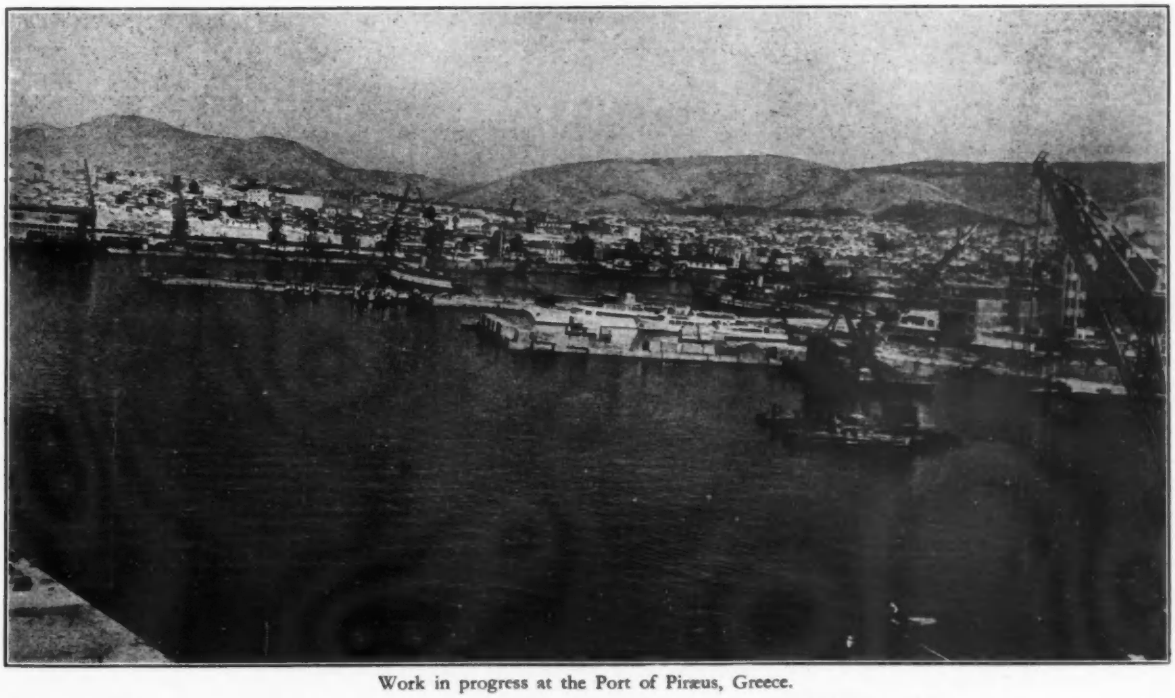

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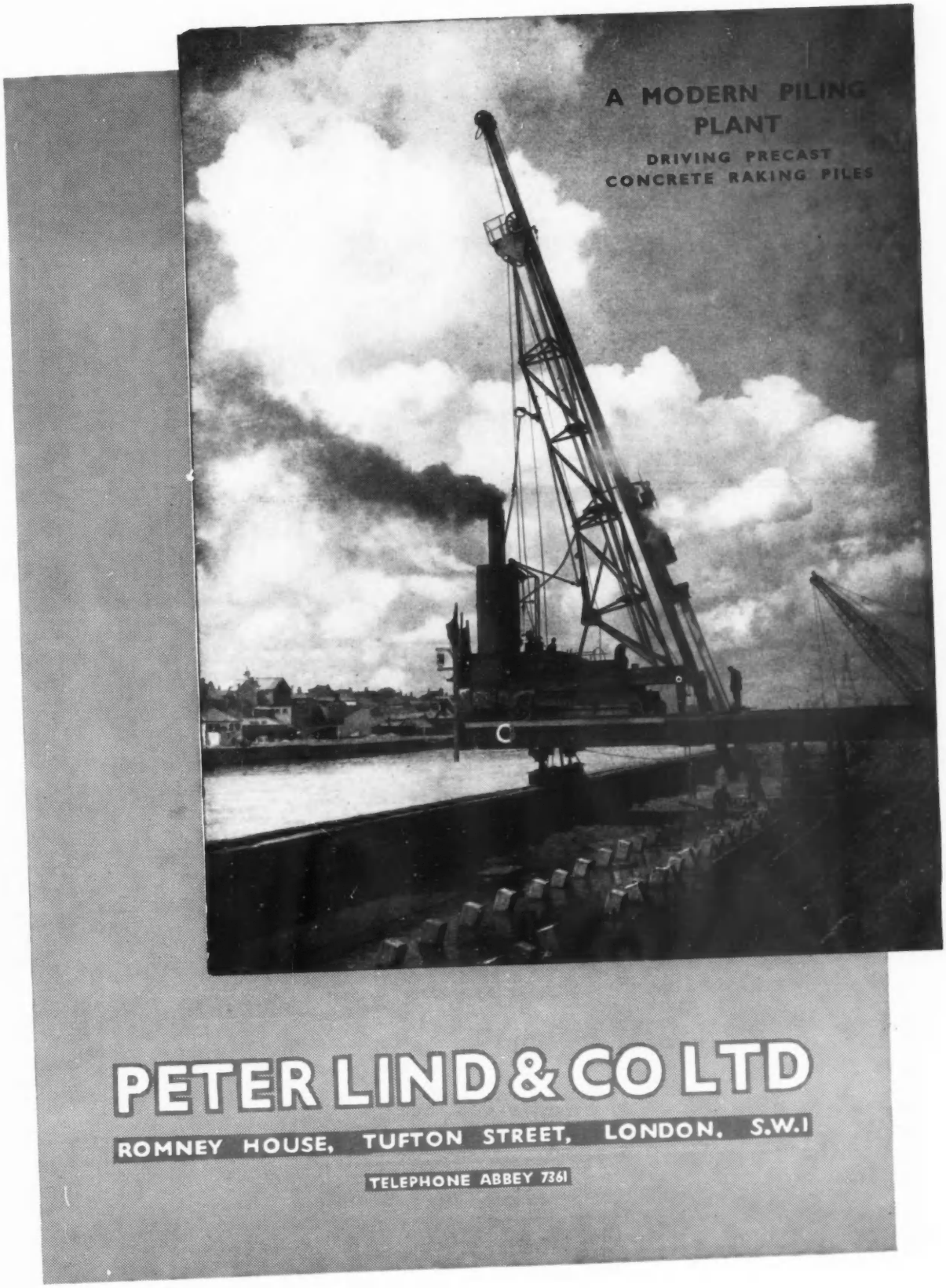
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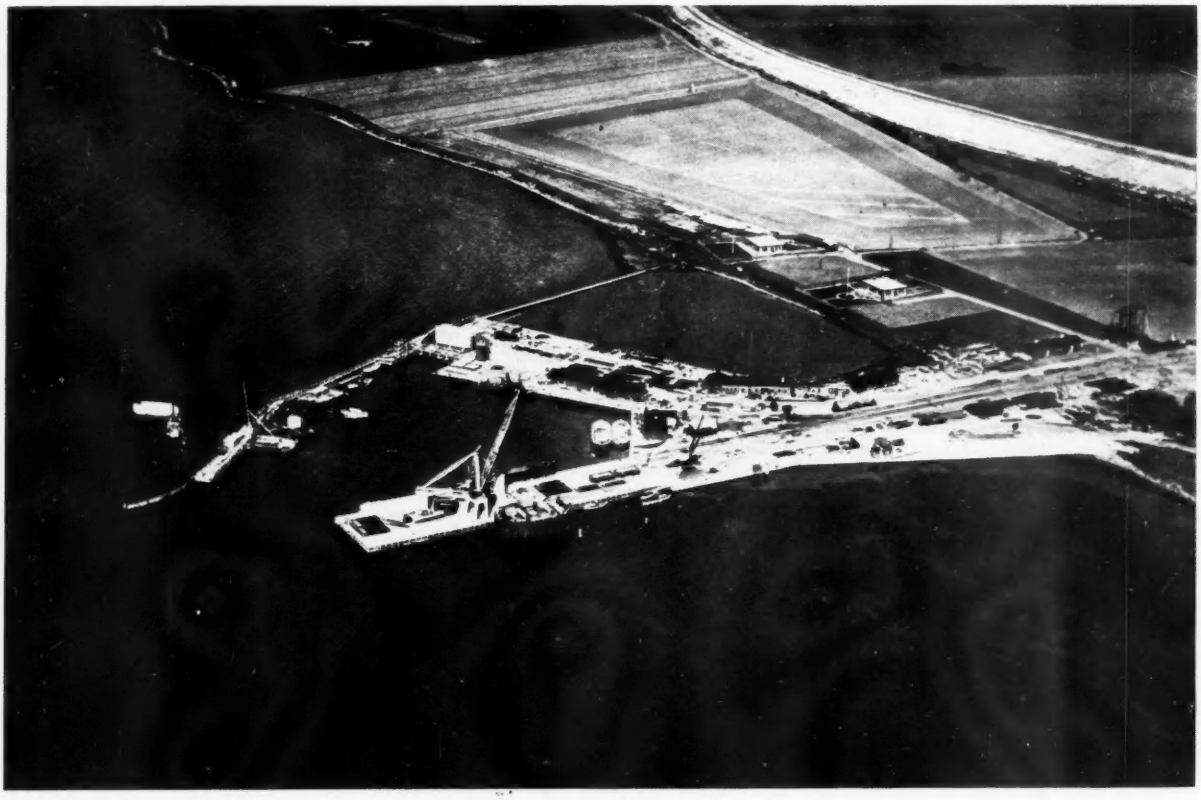

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